

Implementation Strategies

Summary - Providing Opportunities for Achieving Water Quality Benefits and Watershed Enhancement and Restoration

Implementation Plan strategies have been developed to address the anticipated requirements of the Ballona Creek Bacteria TMDL that include (within a single TMDL), the summer dry weather, winter dry weather, and winter wet weather conditions for indicator bacteria. The purpose of this document is to support the California Regional Water Quality Control Board – Los Angeles Region (Regional Board) in the development of the TMDL by developing and evaluating alternative strategies for TMDL implementation.

As a result of the stakeholder driven process employed in developing and evaluating the strategies, a Preferred Strategy was chosen that incorporates an integrated approach and describes a systematic strategy for progressively improving compliance with Ballona Creek Bacteria TMDL objectives, while also providing opportunities for achieving broader water quality benefits and goals for watershed enhancement. Using an iterative, adaptive management process, the Preferred Strategy relies on a combination of measures designed to decrease migration and transport of bacteria, as well as other pollutants such as metals and organics, by reducing the amount of dry weather and wet weather runoff, while at the same time incorporating opportunities for beneficial reuse of runoff. The strategy is consistent with the definition established by the Los Angeles Regional Water Quality Control Board (Regional Board) in the Santa Monica Bay Beaches TMDL and subsequent Basin Plan Amendment:

“An integrated water resources approach is one that takes a holistic view of regional water resources management by integrating planning for future wastewater, storm water, recycled water, and potable water needs and systems; focuses on beneficial re-use of storm water, including groundwater infiltration, at multiple points throughout a watershed; and addresses multiple pollutants for which Santa Monica Bay or its watershed are listed on the CWA section 303(d) List as impaired. Because an integrated water resources approach will address multiple pollutants, responsible jurisdictions can recognize cost-savings because capital expenses for the integrated approach will implement several TMDLs that address pollutants in storm water. An integrated water resources approach shall not only provide water quality benefits to the people of the Los Angeles Region, but it is also anticipated that an integrated approach will incorporate and enhance other public goals. These may include, but are not limited to, water supply, recycling and storage; environmental justice; parks, greenways and open space; and active and passive recreational and environmental education opportunities”.

An Alternative Strategy that focuses on “end-of-pipe” treatment solutions is also considered here. The iterative, adaptive management process, as part of the Preferred Strategy, may ultimately lead to a combination of elements from both the Preferred and Alternative Strategies being used during implementation of the TMDL. As shown in the analysis, there is reasonable assurance that both the Preferred Strategy and the Alternative Strategy will result in compliance with the water quality standards of both the Ballona Creek and the Ballona Estuary.

The Preferred Strategy incorporates elements from a wide range of activities and projects including: (1) institutional flow source control (primarily dry weather); (2) extensive structural/physical flow source control, including beneficial reuse; (3) limited diversion to sewer system (during dry weather only); (4) partial treatment and discharge/return of dry weather flow (possibly using the North Outfall Treatment Facility (NOTF)); (5) limited treatment and discharge/return of wet weather flow (possibly using the NOTF); (6) bacteria source control; and (7) in-stream solutions (primarily for dry weather). Full implementation of this diverse range of activities and projects will require an extended time frame, and a major investment in a wide range of implementation and operational costs. At the same time, many of the activities and projects identified will provide value and benefits that support the implementation of other TMDLs in the watershed.

This Implementation Strategy has been developed through a collaborative stakeholder-based process, facilitated by the formation of the group known as CREST (Cleaner Rivers through Effective Stakeholder TMDLs). CREST was formed in 2004 through a partnership initiated by the City of Los Angeles, the Regional Board, and US EPA Region 9. CREST began focusing on the Ballona Creek Bacteria TMDL in Spring of 2005. The specific activities conducted in support of the Ballona Creek Bacteria TMDL are described in the following sections.

As discussed in this document, a comprehensive Monitoring Plan and a more detailed Implementation Plan will be developed after adoption of the TMDL to define the roles, responsibilities, and commitments by the responsible jurisdictions. The detailed Implementation Plan will describe more specific actions selected by the agencies to implement the Preferred Strategy. The combination of the detailed Monitoring and Implementation Plans will further describe the steps that will be taken toward achieving water quality objectives.

The Water Resource

The Ballona Creek watershed is dominated by urban development, with only 17% open space located predominantly in the northern and upper-most portions of the watershed. The remaining 83% of the Ballona Creek watershed is dominated primarily by a combination of residential land use (high-density and low density) covering nearly 60%, and commercial land use covering nearly 16% of the total watershed area. This high degree of urbanization influences both the hydrology of the watershed and the pollutant loading to Ballona Creek. A map of the Ballona Creek Watershed is shown in Figure 1.

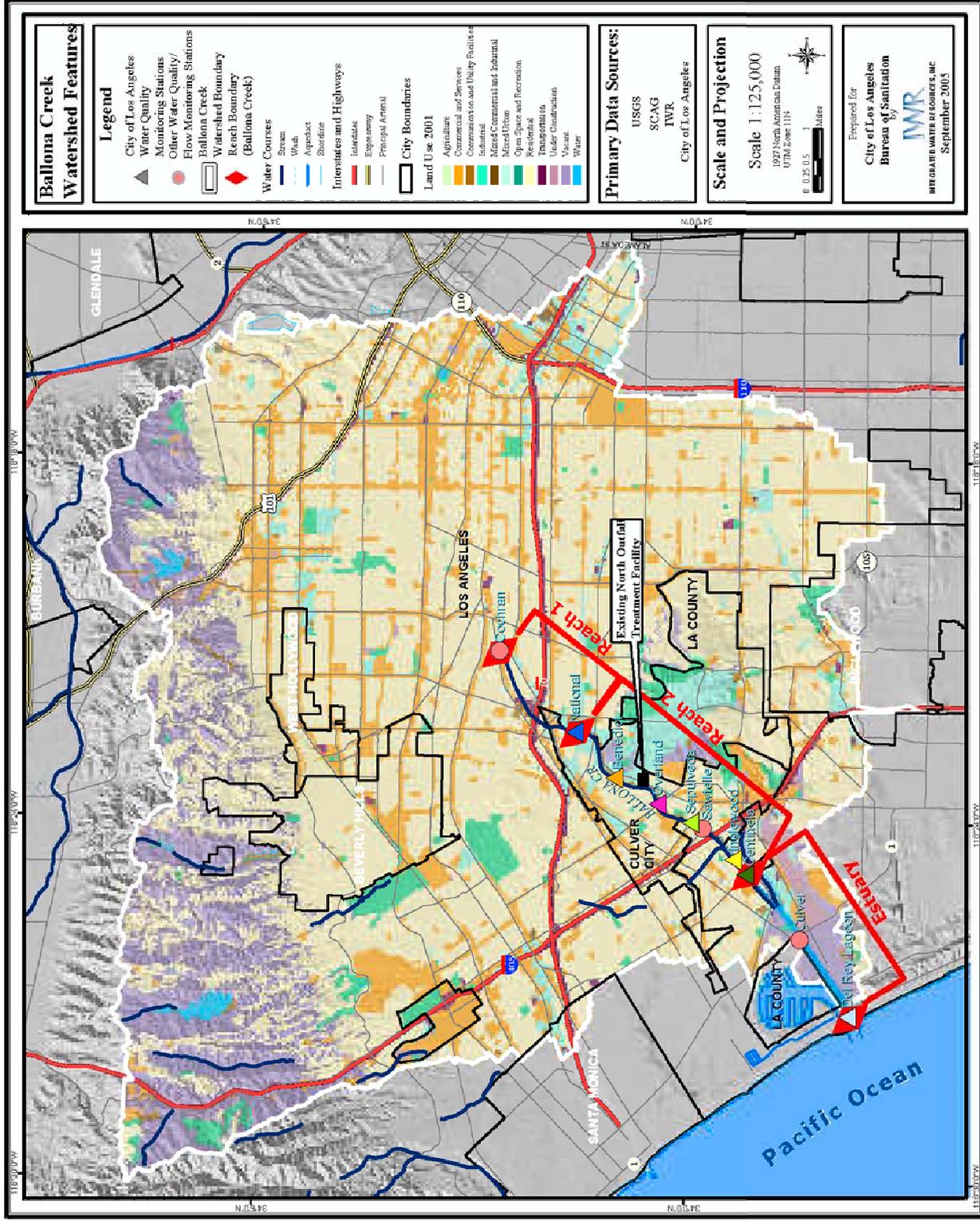


Figure 1
 Ballona Creek Watershed Features

Urbanization leads to changes in the hydrologic response to rain events by both creating a more rapid runoff response and by increasing the total amount of runoff. The increased runoff is caused by reduced rates of infiltration of rainwater, following the conversion of open space to less pervious surfaces. Urbanization around Ballona Creek has resulted in larger amounts of wet weather flows that have led to flood control measures such as construction of underground storm drain systems and concrete lined flood control channels for Ballona Creek and its primary tributaries. The sources of dry weather flows are the combination of nuisance flows (e.g., excess irrigation, car washing) and permitted discharges under the National Pollution Discharge Elimination System (NPDES) discharges (e.g., cooling water, permitted industrial discharges). The persistence of dry weather flows from tributaries and within Ballona Creek results from these increased urban sources, but is also partly the result of the concrete lined flood control channels that prevent distributed, watershed-wide infiltration.

Residential and commercial land uses result in the highest concentrations of bacterial indicators, based on data collected by Los Angeles County from a number of mass emission sites between 1994 and 2000, including one at Ballona Creek. A highly urbanized environment can lead to increased bacterial loading from numerous sources such as pet waste, leaking sewer lines, illegal discharges, and homeless encampments.

General Regulatory Background

This TMDL and its Implementation Plan are created in response to the 303(d) current listing (2002) of the Ballona Creek Estuary, Ballona Creek, and Sepulveda Canyon as impaired water bodies with respect to coliform bacteria. The listing is based on the fact that sampling indicates that water quality has exceeded the water quality objectives established for unrestricted water contact recreational use (REC-1). The regulatory mechanisms employed to implement the TMDL will include the Los Angeles County Municipal Storm Water NPDES Permit, the State of California Department of Transportation (Caltrans) Storm Water Permit, minor NPDES permits, general NPDES permits, general industrial storm water permits, and general construction storm water permits. Each NPDES permit that allows discharges into Ballona Creek or Estuary will be reopened or amended at re-issuance, in accordance with applicable laws, to address implementation and monitoring of this TMDL and to be consistent with the Waste Load Allocations (WLAs) of this TMDL.

Each permittee or group of permittees along with other responsible agencies¹ within a sub-watershed may decide how to achieve the necessary reductions in exceedance days at each compliance point by employing one or more of the implementation strategies discussed below or any other viable strategy. The Porter Cologne Water Quality Control Act prohibits the California Regional Water Quality Control Board-Los Angeles Region (Regional Board) from prescribing the method of achieving compliance with water quality standards, and likewise TMDLs. The Stakeholder Process described in the following

¹ For the purposes of the TMDL, "responsible jurisdictions and responsible agencies" include any local or state agency that (1) is responsible for discharges into the Ballona Creek watershed, or (2) is a permittee or a co-permittee on a municipal storm water permit.

section has identified some potential implementation strategies; however, there is no requirement to follow the particular strategies proposed herein as long as the water quality targets defined in the TMDL are achieved.

There is a strong interest on the part of watershed stakeholders to focus on solutions to reducing bacterial loading in Ballona Creek and improving compliance with bacteria-related water quality objectives that emphasize watershed-based strategies to reduce both wet and dry weather flows, and bacterial source control. Many of these strategies are similar to implementation approaches that may be considered for meeting other TMDLs within the Ballona Creek Watershed including the Ballona Creek Metals TMDL and the Ballona Creek Estuary Toxics TMDL.

CREST Stakeholder Process

The overall stakeholder involvement process assisting with the development of the TMDLs was initiated by the City of Los Angeles, in the summer of 2004 with the creation of "Cleaner Rivers through Effective Stakeholder TMDLs" (CREST). Stakeholders include representatives from cities, the County of Los Angeles, regulatory agencies, and environmental groups with interests in the watershed. The purpose of CREST is to provide a collaborative process for TMDL development. CREST's mission is to "restore and preserve beneficial uses of our rivers and creeks using a collaborative partnership to develop TMDLs and water quality attainment strategies with active and informed involvement by the community and stakeholders and by facilitating effective, innovative, practical, financially feasible, and integrated solutions."

CREST has organized a Steering Committee that meets every other month and a Technical Committee that meets monthly. The City of Los Angeles has contracted with a consultant team to facilitate both the Steering and Technical Committee meetings and to provide technical support and work products. CREST participation is open to all stakeholders, and is chaired by the City, Regional Board, and US Environmental Protection Agency - Region 9 (USEPA).

The CREST Technical Committee and Steering Committees began discussing potential involvement in the Ballona Creek Bacteria TMDL process in the spring of 2005 through briefings from Regional Board staff and discussions at Committee Meetings. It was subsequently determined CREST would become actively involved in assisting the Regional Board in the development of the Implementation Strategies and Monitoring sections of the TMDL (also described under the CREST process as the "Water Quality Attainment Strategy" portion of the TMDL). Stakeholders participated in several sessions to identify a range of potential implementation options, and proposed numerous options that could be incorporated into one or more implementation alternatives designed to meet TMDL compliance. These options are summarized in a matrix (Table 1).

Implementation Option Group		Specific Implementation Option		Considerations	
Flow Source Control	Irrigation Control/ Oversight	Canvass water purveyors for use distribution data	Remote Controlled Irrigation Systems - CIMIS	Review IRP to understand irrigation water use	
	Institutional Educational Programs	Fix leaking Water Supply/Infrastructure	Control the flow to control bacteria	Staff to fix broken sprinklers (cheaper than persuading property owners to fix leaks)	
Watershed Management Perspective Structural/Physical BMPs	Reduce % Impervious	On-site Storage and Re-use	Develop design standards for residents	Identify large flow non-receiving water opportunities	
	On-site Percolation/ Groundwater Recharge	Promote use of "grey" water systems	Local infiltration basin at catch basin near parks and schools	Identify school yards near large drains	
Treatment Plants	Wet Weather - Promote use of Cisterns at individual properties	Dedicated Urban Run-Off Plant (for treatment and Re-use/discharge)	Look at land use layer to determine open space/park/school areas	Identify a "Control" storm drain or small catchment area	
	Dry weather - Low-flow Diversions to POTWs (for treatment and reuse). Wet Weather - Diversions to POTWs not practical or limited to very small flows due to minimal excess wet weather capacity		An additional treatment plant at bottom of watershed is double-duty (LA RIR treated effluent during dry weather)	Placement of treatment important to consider	
Treat and Discharge or Return	Dedicated Urban Run-Off Plant (for treatment and Re-use/discharge)	Dry weather - temporarily divert and disinfect (Use UV or O3). Wet weather, temporarily divert, store, partial solids reduction and disinfect (Use UV or O3).	Possible treatment placement option - bottom of Compton	Wet Weather - very limited except for very small flows due to limited capacity	
	"Reverse" Sanitary Survey		Disinfection only or treat other pollutants		
Aerial source control (residential/open space vs. commercial)	Control high load sources		"Focused" san surveys to identify hot spots - target regular	Implementation timeline too long?	
	Understand High-Load Sources		Limits on sanitary surveys - ephemeral sources	Limits on sanitary surveys - ephemeral sources	
Stream Restoration	Identify Land uses that are Contributing Dry-weather Bacteria		Use SCCWRP study as a starting point for identifying problem sources before they get into the storm	Identify problem sources before they get into the storm	
	Daylight to Prevent Growth/Re-growth; restore streams to natural condition		TMDL compliance for doing watershed inspections	TMDL compliance for doing watershed inspections	
Multi-phase Approach	Identify a Control Drainage Watershed		Task City/County field staff with investigating water quality	Target flow or bacteria concentration hot-spots	
	Simple, short-term solutions at outset, then gather more info for specific correction of hot-spot problems		Hot spots hard to identify; variability for both bacteria and bacteria	Hot spots hard to identify; variability for both bacteria and bacteria	
Pilot Project	Daylight to Prevent Growth/Re-growth; restore streams to natural condition		Limits are so low; therefore important to control both flow and bacteria	Limits are so low; therefore important to control both flow and bacteria	
	Single Catchment Area with Mix of Land uses		Natural bacteria sources (including wildlife and agriculture)	Natural bacteria sources (including wildlife and agriculture)	

In order to evaluate the potential benefits as well as the challenges associated with the numerous individual options identified, the options were grouped into two major categories: 1) strategies to reduce or eliminate flow to the Creek; and 2) strategies to reduce bacteria in discharges and/or creek flow. Strategies that would reduce or eliminate flow to the Creek were further subdivided to identify options that involved: (a) programmatic or institutional (non-structural) flow source control measures, such as irrigation control/oversight and public educational outreach campaigns; (b) structural or physical flow source control measures, such as watershed-based solutions involving reduction of impervious areas, onsite storage and reuse, and/or onsite percolation/recharge; and (c) diversion of flow collected in the storm drain system away from the Creek and/or tributaries either to the wastewater collection system for treatment and discharge with wastewater, and/or possible reuse. Strategies to reduce bacteria in discharges and/or Creek flow were subdivided into options that involved: (a) treatment and discharge flow to the Creek and/or its tributaries; (b) bacterial source control; and c) in-stream solutions, such as “day lighting” sections of the tributaries that are now culverted, or restoration of reaches of currently lined Creek or channels to more natural conditions.

In addition to the specific groups of options discussed above, the stakeholders also expressed the importance of considering combinations of options, multi-phased or adaptive management approaches, and pilot programs during the development of a comprehensive implementation alternative.

Implementation Goals, Objectives and Performance Measures

As TMDLs have been developed for a number of water bodies and pollutants in the area, it has been recognized that there are two general approaches to implementing TMDLs. The first is an integrated water resources approach that takes a holistic view of regional water resources management. The objectives of this approach are to integrate planning for future wastewater, storm water, recycled water, and potable water needs and systems; focus on beneficial re-use of storm water, including groundwater infiltration at multiple points throughout a watershed; and address multiple pollutants. It has been recognized that an integrated water resources approach not only provides water quality benefits, but also that responsible agencies implementing the TMDL can serve a variety of public purposes by adopting an integrated water resources approach. Such an integrated approach allows for the incorporation and enhancement of other public goals such as water supply, recycling and storage, environmental justice, parks, greenways and open space, and active and passive recreational and environmental education opportunities. The alternative to an integrated approach is a plan focused primarily on a single pollutant and on pollutant reduction through treatment and discharge that does not take into consideration other watershed and integrated resource management goals.

The proposed Implementation Plan employs an iterative, adaptive management process by providing a framework to assist the responsible agencies with the identification and implementation of an integrated program of effective and practical solutions to progressively achieve compliance.

An important component of the stakeholder process in the development of an implementation plan for the Ballona Creek Bacteria TMDL was the development of a comprehensive set of criteria, consistent with CREST's stated mission, by which potential implementation strategies could be evaluated. An initial request from a member of the stakeholder group to look at the effectiveness versus cost of the various options was expanded to compare the performance of various potential options against a range of evaluation criteria. Recurring themes from stakeholder Technical and Steering committee meetings were incorporated into a preliminary list of objectives for implementation of the Ballona Creek Bacteria TMDL. These draft objectives were then reviewed and refined by the stakeholder group. The final objectives are provided in Table 2.

The groups of implementation options, as outlined in Table 1, were then compared to these objectives to evaluate which options were best able to meet a range of objectives and should therefore be considered for incorporation into a comprehensive, watershed-wide implementation alternative for which a cost estimate would be developed.

The ability of each option to meet a particular objective was ranked qualitatively (high, medium, or low), and compared to other proposed options. Performance rankings were based on a collaborative assessment by the Technical Committee, and incorporated considerations identified during stakeholder discussions. This ranking process was conducted for the purposes of promoting stakeholder discussion about the viability of the various potential options. The results of ranking are presented in a series of bar charts [Attachment A]. The results of these individual comparisons of performance against objectives were then summed to examine the ability of a potential implementation option to meet the entire range of CREST objectives, under either the dry weather or wet weather scenario (Figure 2a and 2b).

Options involving flow source control (both institutional and dispersed, watershed-wide structural solutions) and the treatment and return of tributary and/or Creek flows ranked higher compared to other implementation objectives, as shown above in the summary bar charts (Figures 2a and 2b). Stakeholders expressed a preference for implementing an alternative that incorporates the ability to meet a range of long-term goals for the watershed, consistent with planning strategies outlined in the City of Los Angeles' Integrated Resource Plan (IRP). Based on these summary results and additional stakeholder input a strategy that emphasizes watershed-based and integrated solutions was determined to be the preferred approach for TMDL implementation. This strategy also builds on other Ballona Creek TMDLs and watershed planning efforts and activities as described in the following subsection. In addition, an alternative strategy was also formulated that focuses much more on "end-of-pipe" structural solutions. Both the Preferred and Alternative Strategies are described in detail under Potential Implementation Strategies for Ballona Creek Bacteria TMDL. A suggested schedule for

implementation of the Preferred Strategy is presented in the following subsection, followed by a discussion of cost estimates for both the Preferred and Alternative Strategies.

Objective	Potential Performance Measure
1 Protect Public Health and Safety	
1.1 Protect for Recreation Use (where designated)	Pathogen count reduction (e.g., <i>E. coli</i> or fecal coliform)
1.2 Protect from Safety Hazards	Safety hazard protection (e.g., flood hazards) -Not Applicable to Dry Weather
2 Protect the Environment	
2.1 Improve/Restore Habitat in Natural Surface Waters	Miles of river habitat revitalized; number/diversity of aquatic species; miles of riparian habitat; acres of riparian wetlands
2.2 Provide for Water Supply Benefits from Runoff Management	Amount of dry and wet runoff used for irrigation or groundwater recharge
3 Protect Quality of Life	
3.1 Provide Open Space/Enhance Land	Acres of increased open space.
4 Improve Compliance Certainty	
4.1 Certainty to Meet Target Levels	Proven technology (high certainty) to emerging technology (low certainty)
5 Enhance Cost Efficiency	
5.1 Provide Lower Cost Solutions	Life cycle costs, expressed as average household monthly cost
6 Provide Adaptable Solutions	
6.1 Effective Under Wet Weather Flow Conditions	
6.2 Effective for Other TMDLs (metals, toxics)	
6.3 Ability to Implement Phased Approach	
6.4 Applicable over Entire Watershed	
7 Improve Implementation Timeline	
7.1 Improve Implementation Timeline	Years to implement

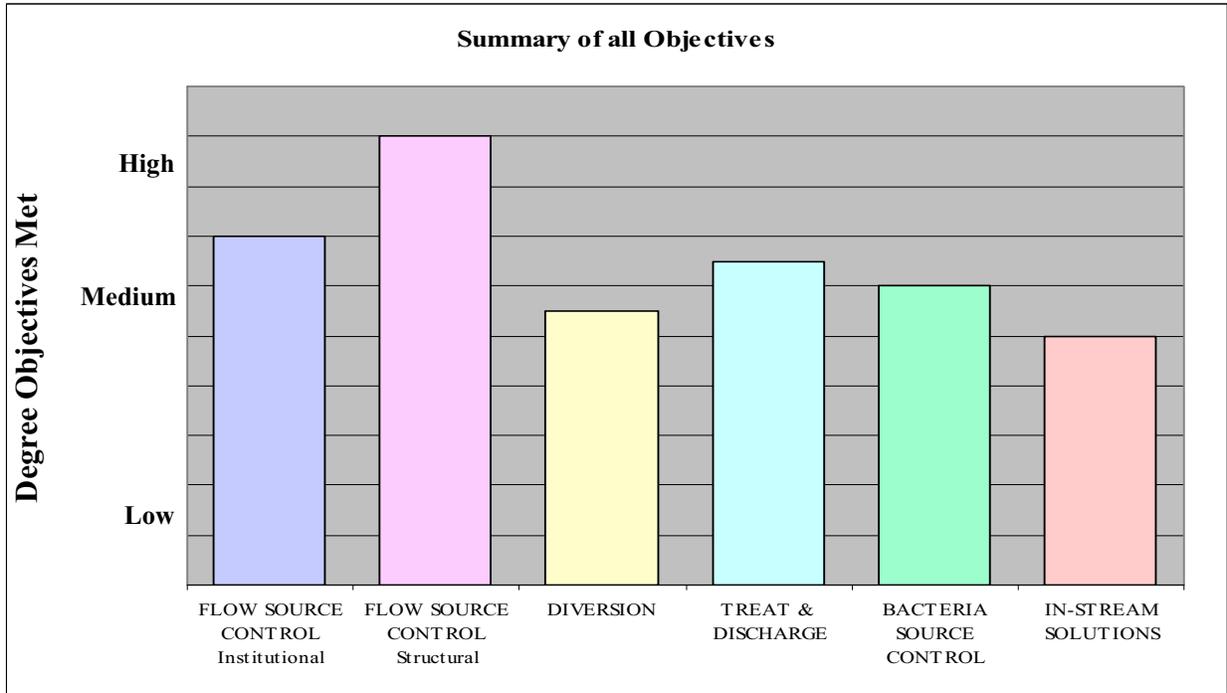


Figure 2a
 Ballona Creek Bacteria TMDL – Dry Weather Options Summary Chart

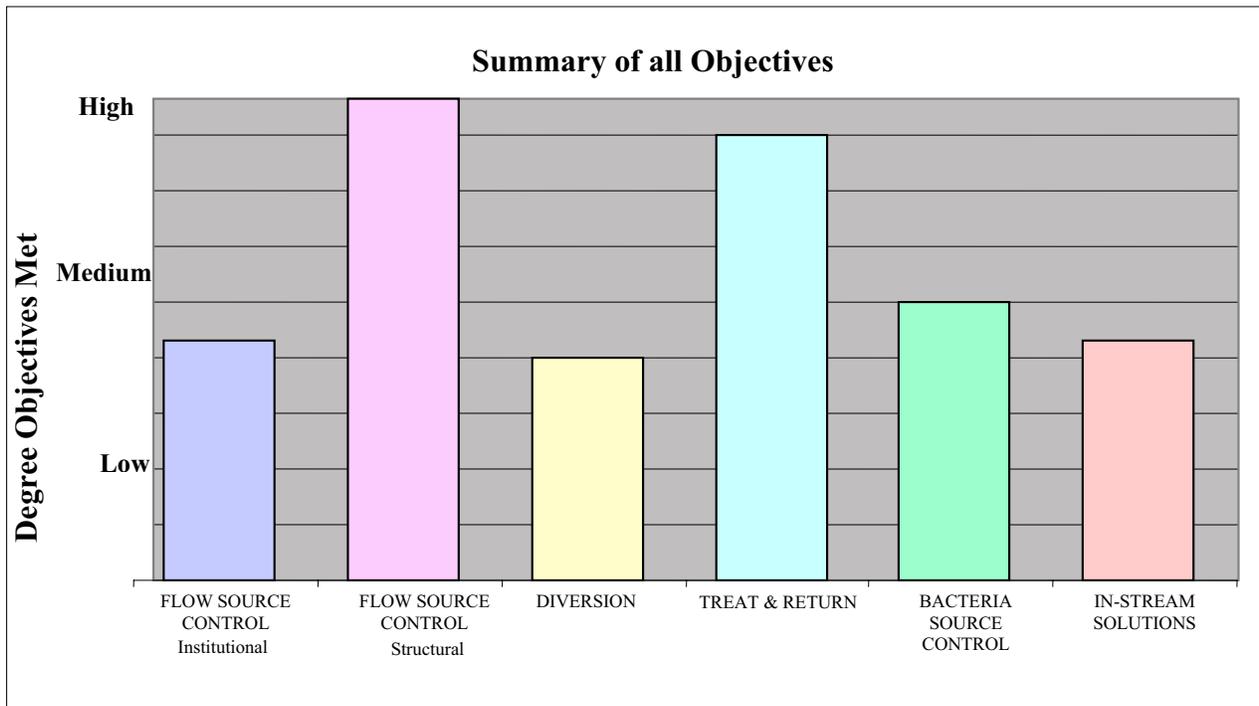


Figure 2b
 Ballona Creek Bacteria TMDL – Wet Weather Options Summary Chart

Implementation Strategies of Other Ballona Creek TMDLs and Other Current Watershed Planning Efforts and Activities

An integrated water resources approach to improving water quality for Ballona Creek has been outlined by the City of Los Angeles' Integrated Plan for the Wastewater Program (IPWP). In particular, Phase 2 of the IPWP resulted in the Integrated Resource Plan (IRP) which is a City-wide strategy developed to increase the amount of wet weather urban runoff that can be captured and beneficially used in Los Angeles. Increased capture and beneficial use of wet weather runoff alone may not be sufficient to achieve waste load allocations. Therefore, the implementation strategies proposed below, while emphasizing watershed based flow and bacterial source control, also include additional measures to increase the probability that TMDL requirements can be met.

Several TMDLs have been, or are in, the process of being implemented for Ballona Creek. This includes the Trash TMDL (effective date August 2, 2002), a Metals TMDL, and a Toxics TMDL both of which were adopted by the Regional Board in July of 2005 and approved by the State Water Resources Control Board and the USEPA Region 9 in December of 2005. The Trash TMDL calls for a combination of institutional controls and capture systems to meet TMDL requirements. A secondary benefit of trash removal systems will be the capture and removal of sediment and associated pollutants. The Metals TMDL calls for structural and non-structural watershed-wide implementation of Best Management Practices (BMP) implementation, together with diversion and treatment strategies for high volume wet weather flows.

Implementation of these other TMDLs will also assist with meeting the goals of the Bacteria TMDL. As an implementation plan for the Bacteria TMDL is finalized, the implementation plans for the other TMDLs (Metals and Toxics) should be reviewed to ensure consistency of approach and coordination.

The City of Los Angeles's Integrated Resources Plan alternatives, currently undergoing detailed environmental analyses, all include components for the significant beneficial reuse of urban runoff with multiple benefits that helping to meet both reuse and TMDL requirements. The comprehensive Ballona Creek Watershed Management Plan, completed in September 2004, recommends implementing a wide range of projects and activities that will enhance water resources (both quantity and quality), land and planning goals and objectives for the watershed. The water quality objectives recognize the need to improve water quality and implement the TMDLs. An initial list of potential projects that have water quality benefits, which include meeting the Bacteria TMDL is identified in the Management Plan. These projects and activities generally address one or more of the implementation option groups noted in Table 1 including:

- Institutional flow source control;
- Structural/physical flow source control;
- Partial dry weather treat and discharge/return;

- Bacteria source control;
- In-stream solutions.

The Ballona Creek Watershed Task Force is moving forward with planning and implementation of a number of the projects identified in the Management Plan and is seeking grant funding under Proposition 50 and Proposition O. The Watershed Plan also identifies a number of ongoing or proposed community-based monitoring activities that can be integrated with a monitoring program for the TMDL as discussed under the Monitoring Program Section.

Another effort underway is the Ballona Creek BMP Prioritization Project. In 2003, the Santa Monica Bay Restoration Commission initiated a Ballona Creek BMP Project Work Group, to implement a BMP prioritization project for the Ballona Creek Watershed and monitor effectiveness of BMPs in treating 303(d) listed pollutants. In later phases, this work group is developing a planning and implementation strategy that can be used by municipalities to successfully plan, design, implement, and monitor structural retrofit BMPs for storm water quality management. The outcome of this study will assist the stakeholders in identifying and prioritizing watershed projects and BMPs for implementation relative to their effectiveness in meeting the TMDL requirements.

A third activity that has been started and may provide assistance that can specifically quantify potential pollutant reduction (including bacteria) as a result of a variety of implementation measures throughout the watershed is the development and application of Watershed Models for BMP simulations in Ballona Creek. Southern California Coastal Water Research Project (SCCWRP) has initiated this project as a collaborative effort with the City of Los Angeles, the Regional Board, U.S. EPA and others. The models have the potential for providing a more rigorous analysis and prediction of the pollutant reduction that could be realized through extensive implementation of a wide range of non-structural and structural measures such as those included in the Preferred Strategy. Initial model development and calibration and some preliminary predictive runs have been conducted for a limited number of BMP approaches/assumptions and several indicator constituents including bacteria. The models could be further developed and applied as part of the implementation phase of the TMDL to help guide decisions.

Potential Implementation Strategies for Ballona Creek Bacteria TMDL

As noted earlier, two different strategies for achieving compliance with the TMDL were developed by the stakeholders using a combination of the Options listed in Table 1. The "Preferred Strategy" provides an integrated resources approach to the TMDL implementation and meets a range of other long-term watershed planning goals. This "Preferred Strategy" relies on a combination of options, including flow and bacteria source control, with limited treatment and discharge as well as a small amount of diversion to the Hyperion Treatment Plant (HTP). As described earlier, some of the activities and projects that can begin to address this strategy are already in the planning phase by certain stakeholder groups in some areas of the watershed. An "Alternative Strategy" was also

developed that relies more heavily on the capture, treatment and discharge of stormwater. This strategy was developed to compare the preferred strategy against an alternative that is based on more conventional engineering and construction with potentially lower risk of non-compliance but much greater investment in infrastructure and much less opportunity to achieve multiple objectives.

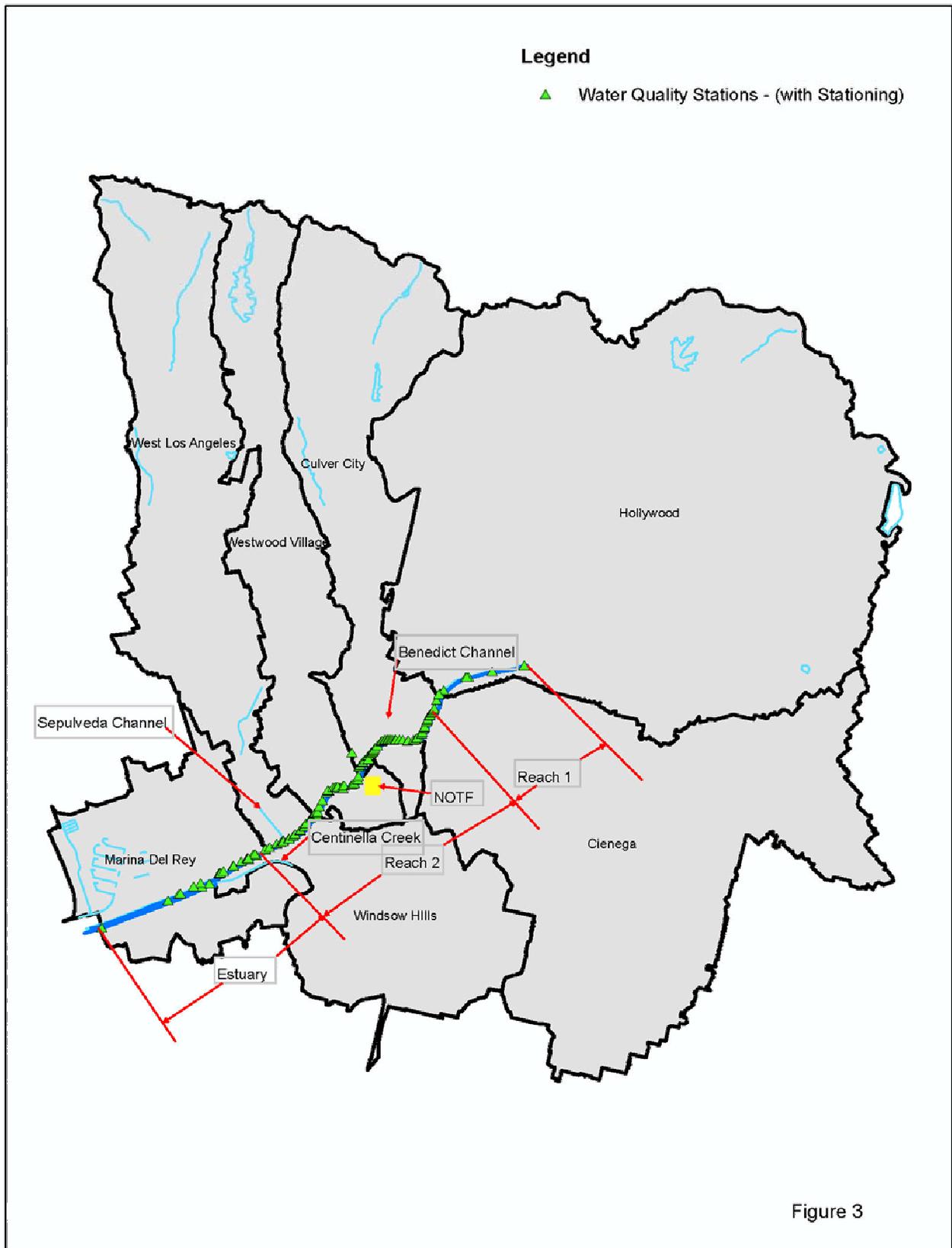
In implementing the TMDL, responsible jurisdictions and agencies will likely include a combination of the various options presented in the Preferred and Alternative Strategies. It is assumed that this combination of options which includes institutional and structural flow source control, various options for treat and discharge, bacteria source control, and in-stream solutions will result in compliance with water quality objectives. The TMDL Implementation Schedule presented here also includes a phased approach, that monitors progress and ensures that milestones and interim goals are met towards water quality objectives.

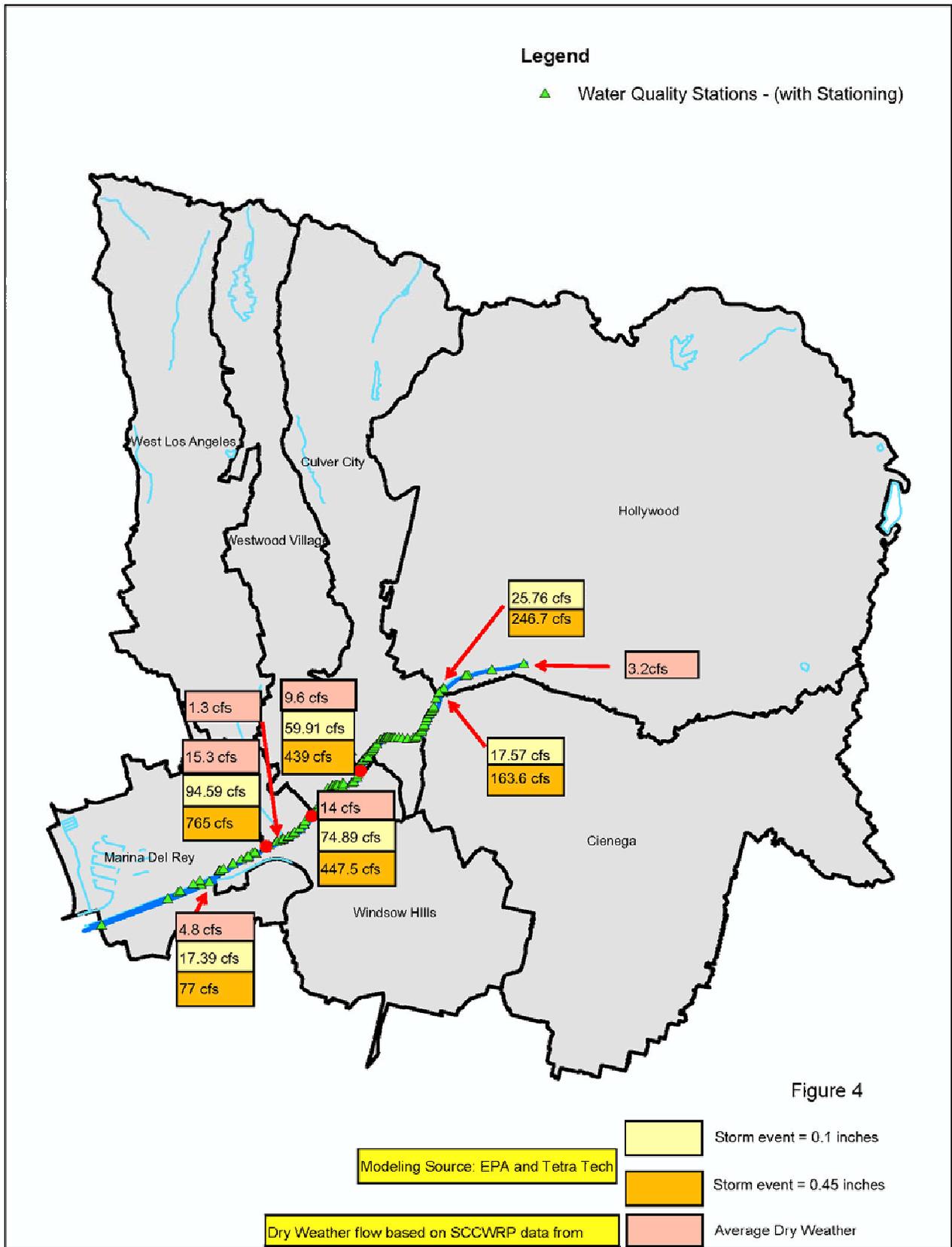
The facilities required for the Preferred Strategies include use/conversion of the existing North Outfall Treatment Facility (NOTF) as well as new diversion facilities within select tributaries. The NOTF is located on the south bank of Ballona Creek, approximately midway in Reach 2 (Figure 1). The facility was constructed, and is owned, by the City of Los Angeles for use as a sewage overflow structure to prevent untreated wastewater overflows discharging to Ballona Creek. The facility provides 1 million gallons of storage capacity with a capacity for treatment of up to 150 cfs (Ballona Creek Treatment Facility Feasibility Study and Preliminary Design; City of Los Angeles Bureau of Engineering Report). The NOTF is currently not in use.

The Alternative Strategy would require new facilities (multiple new treatment plants) and diversion facilities designed to collect wet weather flow and direct it to the above-mentioned new treatment facilities. The new diversion facilities which may return wet weather flow to the creek after treatment, would also direct all dry weather flow to Hyperion Treatment Plant (HTP), to transfer the water completely out of the creek.

A simplified map of the subwatersheds is shown in Figure 3. The dry and wet weather flow assumptions used for developing and evaluating the strategies are shown in Figure 4. Table 3 summarizes key features of each strategy.

Option Group	Preferred Strategy	Alternative Strategy
Institutional Flow Source Control	Included (primarily dry weather)	Included (primarily dry weather)
Bacteria Source Control	Included	Included
Structural Flow Source Control	Extensive – Primary strategy	Limited -- Opportunistic Only
Flow Diversion (Dry Weather)	<ul style="list-style-type: none"> ▪ Upper Watershed – divert for reuse ▪ Lower Watershed – divert to sewer system (or possible wetland) 	Divert all watersheds to sewer system for treatment (reuse optional)
Treat and Discharge/Return	<ul style="list-style-type: none"> ▪ Dry Weather – upper watershed treat and discharge at NOTF ▪ Wet Weather – limited treat and discharge or reuse at NOTF site 	Wet weather – capture, treat and discharge or reuse at three new sites (Dry weather flow diverted to HTP)
In-stream Solutions (Dry Weather)	Incorporate where feasible	Not included





Description of Preferred Strategy – Emphasize Watershed-based and Integrated Solutions for Progressively Achieving Compliance

The Preferred Strategy relies primarily on an integrated water resources approach. This approach takes a holistic view of regional water resources by integrating planning efforts focused on beneficial re-uses of stormwater and other multi-purpose goals.

This strategy incorporates the following options, in decreasing order of reliance:

- Institutional flow source control (e.g. public education, irrigation controllers) (primarily dry weather);
- Bacteria source control (e.g enforcement of litter ordinances, street sweeping);
- Structural/physical flow source control;
- Limited wet and dry weather treatment and discharge and/or reuse at NOTF;
- Partial diversion of lower sub-watershed tributaries to HTP (dry weather only);
- In-stream solutions (primarily dry weather).

Below is the general description of the Preferred Strategy:

- **Institutional flow source control** - Implement aggressive institutional flow source control strategies to reduce dry weather runoff throughout the watershed (see Figures 3 and 4 for simplified maps of watershed and sub-watersheds). A target of 25% redirection of dry weather flows has been established based on estimates developed under the LAIRP and the Santa Monica Bay Beaches TMDL Implementation Plan.
- **Bacteria source control** - Implement aggressive institutional bacterial source control strategies to reduce bacteria densities in dry and wet weather runoff.
- **Structural/physical source control** - Implement extensive structural flow source control (i.e., onsite capture for infiltration, use, and treatment) throughout the watershed. Reuse portion of captured water where possible.
- **Treatment and discharge/reuse** - Divert, treat and return to Creek or reuse as much wet weather flow as possible at the NOTF without adding additional storage. In addition, capture cumulative dry weather flows in the Creek at the NOTF (average 7 cfs, plan for maximum 15-23 cfs, which is high-end of dry weather flows); treat 100% of flow at a minimum to meet REC-1 water quality objectives (WQOs); reuse up to approximately 4 cfs of treated water in accordance with the IRP reclaimed water plan and additional treatment equivalent to Title 22 requirements for unrestricted irrigation for reuse water. Return to creek the remaining balance of treated dry weather flow not delivered for reuse (between 3 cfs and 19 cfs).

- **Diversion to HTP** - Divert 100% of the remaining dry weather flows downstream of NOTF from Westwood Village (un-named tributaries), West L.A. (Sepulveda Channel) and Windsow Hills (Centinela Channel) sub-watersheds to HTP from multiple locations within Ballona Creek or tributaries. If feasible, consider alternative possible diversion of Windsow Hills sub-watershed (Centinela Channel) water to a constructed wetlands facility.
- **In-stream solutions** - Provide in- stream treatment through Creek restoration and/or storm drain daylighting (conversion to open channel) where feasible. This option would potentially provide an opportunity for bacteria reduction under dry weather conditions only).

Summary of Dry Weather flows under Preferred Strategy:

Hollywood, Cienega, Culver City, Westwood Village, West L.A. sub-watersheds

Average Dry Weather Flow at Sawtelle Ave.	14 cfs
After 25% reduction (3.5 cfs) from source control	10.5 cfs
Average Flow available for capture at NOTF	7 cfs
NOTF flow treated for Reuse	4 cfs
NOTF flow treated for discharge to BC	3 cfs
Average Flow to be diverted to HTP from tributaries below NOTF	3.5 cfs
Average treated flow reaching top of estuary	3 cfs

Windsow Hills sub-watershed (Centinela Channel)

Average Dry Weather Flow	4.8 cfs
After 25% reduction (1.2 cfs) from source control	3.6 cfs
Flow to be diverted to HTP or to a constructed wetland	3.6 cfs

There is a reasonable assurance that implementation of the above combination of implementation measures will provide sufficient reduction of flow and/or bacteria within the watershed to achieve the final dry and wet weather bacteria targets specified in the TMDL. This assumption will be periodically reviewed through evaluation of monitoring data at future implementation milestone points.

Description of Alternative Strategy – Divert Dry Weather Flow and Intercept, Treat, Temporarily Store, Disinfect and Discharge Wet Weather Runoff

In addition to the Preferred Strategy described above, CREST also developed an Alternative Strategy for achieving compliance with the Ballona Creek Bacteria TMDL that relies primarily on the capture, treatment and reuse and/or return of stormwater to the Creek. The alternative to the Preferred Strategy was developed for two reasons. First, stakeholders wanted to explore the range of potential implementation strategies in order to compare the cost-effectiveness and the relative benefits of the two end-member

implementation scenarios. Second, the Alternative Strategy was developed to address the possibility of a shorter implementation timeline for compliance with the TMDL. The dispersed, watershed-based solutions that are the primary focus of the Preferred Strategy may require longer implementation timelines and adaptive management approaches; whereas, the Alternative Strategy could potentially provide compliance with the WQOs in a potentially shorter timeline although siting and construction of new capture and treatment facilities will also require significant time.

The primary differences between the Alternative Strategy from the Preferred Strategy is the incorporation of three capture storage and treatment facilities for wet weather flow and the diversion of all dry weather flows to HTP.

The Alternative Strategy incorporates the following elements, in decreasing order of reliance:

- Institutional flow source control (e.g., public education, irrigation controllers) (primarily during dry weather);
- Bacteria source control (e.g., enforcement of litter ordinances, street sweeping);
- Structural source control (limited);
- Capture, store, treat and discharge (wet weather);
- Full diversion to sewer system (dry weather only).

Below is the general description of the Alternative Strategy:

- **Institutional flow and bacteria source control** - Implement institutional source control strategies to reduce dry weather flows and bacteria throughout the watershed.
- **Structural source control** - Implement structural flow source control (i.e. onsite capture for infiltration, use) options on an opportunistic basis throughout the watershed, where feasible.
- **Capture, store, treat and discharge** - Temporarily divert, capture, treat and discharge and/or reuse wet weather flow at three new treatment facilities located at strategic locations with sufficient capacity to capture the runoff from approximately 0.45 in of rainfall across all sub-watersheds (Figure 3). This estimate was originally developed as a theoretical target storm event to approximately represent the 17th largest storm event in the 90th percentile (total rainfall days) year for the SMBB TMDL Waste Load Allocation. While not a regulatory standard, this provides an order-of-magnitude runoff target for facility sizing. This includes treatment facilities to serve the Upper Watershed (Proposed Treatment Plant 1), West L.A. and Westwood Village sub-watersheds (Sepulveda Channel and unnamed tributaries; Proposed Treatment Plant 2), and Windsov Hills sub-watersheds (Centinela Creek; Proposed Treatment Plant 3).

- Full diversion to sewer system** - Divert cumulative dry weather flows in the Creek at North Outfall Treatment Facility less source control reductions (7-8 cfs on average; plan for max 15-23 cfs, which is the maximum dry weather flow) to HTP at the sewer junction structure near the North Outfall Treatment Facility. There would be no return of flows to the creek under this strategy. Note that although this strategy does not focus on reuse of runoff, it would be possible to construct a facility similar to that described under the Preferred Strategy for treatment and reuse of up to 4 cfs of runoff. Divert 100% of the remaining dry weather flows from Westwood Village, West L.A. (Sepulveda Channel), and Windsow Hills (Centinela Channel) sub-watersheds, downstream of NOTF, to HTP at multiple locations within Ballona Creek or tributaries.

Summary of Dry Weather flows under Alternative Strategy:

Hollywood, Cienega, Culver City, Westwood Village, West L.A. sub-watersheds

Average Dry Weather Flow at Sawtelle Ave.	14 cfs
After 25% reduction (3.5 cfs) from source control	10.5 cfs
Average Flow diverted to HTP in Reach 1	3 cfs
Average Flow diverted to HTP at NOTF	4 cfs
Flow to be diverted to HTP from tributaries below NOTF	3.5 cfs

Windsow Hills sub-watershed (Centinela Channel)

Average Dry Weather Flow	4.8 cfs
After 25% reduction (1.2 cfs) from source control	3.6 cfs
Flow to be diverted to HTP	3.6 cfs

Assumptions for Preferred and Alternative Strategies

- Institutional and structural flow source control measures can achieve 25% reduction in dry weather flows reaching Ballona Creek (i.e., control up to 3.5 cfs).
- North Outfall Treatment Facility will be available under the preferred alternative for the treatment of bacteria. Treatment costs for other constituents (i.e., metals, toxics) are not considered here. Bacterial treatment methods to be considered are: ultraviolet (UV) disinfection, or chlorination-dechlorination. Treatment for discharge to be below REC-1 standards (possibly accomplished with limited filtration). Treatment for reuse to include direct filtration and disinfection. Other technical, environmental, and regulatory feasibility issues (i.e., permitting, other environmental impacts to creek) would need to be addressed when stakeholders develop the Implementation Plan Report.

- Diversion of dry weather flow from creek is not expected to adversely impact beneficial uses at the estuary. Earlier discussions of this issue at CREST, although not definitive, indicated that flow in the estuary is dominated by tidal flow and as such, estuarine conditions will not be significantly affected by some diversions of the creek. Implementation of the combination of options under the Preferred Strategy would still leave significant but potentially reduced dry weather flow in Ballona Creek. Implementation of the Alternative Strategy could largely eliminate dry weather flow in the creek and therefore have potentially greater impacts on Beneficial Uses. The implications of reduced or eliminated flow in the creek may require evaluation as discussed under Special Studies. It should also be noted that there are other permitted dry weather flows to Ballona Creek (e.g., cooling water) that are low in bacteria that could remain in the Creek wherever possible to provide a source of low bacteria flows.
- Available Hyperion Treatment Plant (HTP) dry weather capacity on average of up to 15 cfs (9.7 mgd) with peak capacity of twice that much.
- Assume one diversion location for each of the lower sub-watersheds (West Los Angeles (Sepulveda Channel) and Windsow Hills (Centinela Channel)). Actual data on amount of dry weather flow from these two sub-watersheds is very limited.
- Assumes sewer system tie-ins/junctions with sufficient capacity exist in locations near the Creek.
- Assumes sufficient land area at a location on the south side of Ballona Creek can be obtained/allocated for use as a treatment wetlands of Windsow Hills sub-watershed dry weather flows (Centinela Channel).
- Wet weather includes on-site and sub-watershed capture, infiltration, use and/or bacteria reduction treatment controls.
- Projects and opportunities identified in Ballona Creek Watershed Management Plan, Prop 50 grant application and other sources represent good starting opportunities.
- Use maximum wet weather storm event volumes for 0.45 inch rainfall event. Exceedances at 90 percentile rainfall year may be greater than allowable under TMDL, but still significantly reduced for many years and under 17 days for some years.

Implementation Schedule

The proposed implementation schedule is based on a phased approach as discussed below and outlined in Table 4. The schedule outline in this Technical Memorandum focuses on activities in the early phases of TMDL implementation that allows the responsible jurisdictions and agencies time to: 1) begin early implementation of a number of activities toward the preferred watershed-based and integrated strategy; 2) begin implementation of long-term activities; and 3) conduct targeted special studies described further in the following section.

**Table 4
Potential Ballona Creek Bacteria TMDL Implementation Schedule**

Time after BC Bacteria TMDL Effective Date	Implementation Activity/Compliance Target		
	Estuary (Mouth)	Reach 2 and Sepulveda Channel	Reach 1
12 months	<ul style="list-style-type: none"> Responsible jurisdictions and agencies submit and obtain Regional Board approval of a comprehensive monitoring plan. 		
18 months	<ol style="list-style-type: none"> Responsible jurisdictions and agencies provide a draft Interim Report to the Regional Board outlining how each intends to cooperatively achieve compliance with the TMDL. The report shall include implementation methods, an implementation schedule, and proposed milestones. Specifically, the plan must include 1) a comprehensive description of all steps to be taken to meet the summer dry weather compliance schedule for the estuary and 2) the specific milestones associated with the 6-Year intervals for the inland reaches and the named tributaries. 		
	<ol style="list-style-type: none"> If the responsible jurisdiction or agency is requesting an extension of the summer dry-weather compliance schedule, the plan must include a description of all local ordinances necessary to implement the detailed work plan and assurances that such ordinances have been adopted before the request for an extension is granted. 		
	<ol style="list-style-type: none"> If a responsible jurisdiction or agency is requesting a longer schedule to the wet-weather compliance schedule based on an integrated approach, the plan must include a description of the integrated water resources (IRP) approach. Compliance with the wet-weather allocations shall be as soon as possible but under no circumstances shall it exceed the time frame adopted in the TMDL for non-integrated approaches or for an integrated approach. 		
3 months after receipt of RWQCB comments on draft	<ol style="list-style-type: none"> Responsible jurisdictions and agencies submit a Final Interim implementation Report to the Regional Board. 		
1-4 Years	<ul style="list-style-type: none"> Conduct special studies with the potential to change the TMDL. Results to be reported by the end of Year 4. 		
2-5 Years	<ul style="list-style-type: none"> Initiate implementation of flow and bacteria non-structural source control measures and dry weather flow management projects (diversion, capture treat and return or reuse) Initiate planning and where feasible implement structural source control measures 		
5 years	<ul style="list-style-type: none"> Reconsider TMDL based on revisions to SMBBB TMDL and results of special studies. 		
6 years	<ul style="list-style-type: none"> Submit an Updated Implementation Plan based on Special Study Results and potential TMDL revisions 		
6 Years	<ul style="list-style-type: none"> No exceedances due to summer dry weather flows. 	<ul style="list-style-type: none"> Achieve interim implementation milestones to be described by each responsible jurisdiction in the detailed implementation plan. 	<ul style="list-style-type: none"> Achieve interim implementation milestones to be described by each responsible jurisdiction in the detailed implementation plan.
	<ul style="list-style-type: none"> Achieve 10% reduction from the total wet weather exceedance-day reduction 		
	<ul style="list-style-type: none"> Achieve compliance with allowable number of exceedance days – 3 winter dry weather days (under daily sampling) or 1 winter dry weather day (under weekly sampling) for Ballona Creek mouth (bottom of estuary) 		
10 Years	<ul style="list-style-type: none"> Achieve 25% reduction from the total wet weather exceedance-day reduction 	<ul style="list-style-type: none"> No exceedances due to summer or winter dry weather flow Achieve 15% reduction from total wet weather exceedance-day reduction 	<ul style="list-style-type: none"> Achieve 15% reduction from total wet weather exceedance-day reduction
See Text Discussion	<ul style="list-style-type: none"> Achieve final wet weather exceedance-day reduction. 		

It was recognized that in the Santa Monica Bay Beaches Bacteria TMDL a compliance schedule is already established for the mouth of Ballona Creek which calls for full wet weather compliance within 18 years of the effective date of that TMDL (December 12, 2020). Regional Board staff have indicated that final wet weather compliance dates for the Ballona Creek Bacteria TMDL should be consistent with the Santa Monica Bay Bacteria TMDL. Because the Ballona Creek Bacteria TMDL will not be adopted until late 2006 (close to four years after the effective date of the SMBB Bacteria TMDL), this would potentially result in an overall shorter final time frame for full implementation for the Ballona Creek Watershed.

Stakeholders responsible for implementation acknowledge that full wet weather compliance must be achieved by this date at the mouth of Ballona Creek. However, they are concerned that achieving full wet weather compliance at other locations in the watershed (particularly in Reaches 1 and 2 and tributaries) within 3 years for dry weather and 14 years for wet weather will have challenges. For many of the Santa Monica Bay storm drains, planning and/or construction of diversion facilities were already under way at the time of TMDL adoption which is not the case for the Ballona Creek watershed. In addition, relatively short deadlines could result in driving dry weather solutions toward more sewer system diversions, which is not the focus of the Preferred Strategy. The Preferred Strategy could require a longer time frame for implementation, due to its approach that emphasizes distributed, watershed-wide measures, and reuse that can address multiple pollutants as opposed to the a largely treatment-and-diversion approach that focuses primarily on bacteria reduction only.

The ability to achieve compliance target dates for the Ballona Creek watershed will be dependent on the results of some of the Special Studies discussed below and the incremental measure of success in starting to implement an adaptive and integrated approach to compliance. It was therefore decided that CREST's input to the schedule should focus principally on this early implementation phase (approximately the first six years). Table 4 presents a summary of anticipated compliance activities and proposed dates during the first ten years following adoption of the TMDL based on pursuing an IRP strategy.

The proposed implementation activities shown in Table 4 within the first ten years are summarized as follows:

- Develop and submit a comprehensive Monitoring Plan and obtain Regional Board approval within 12 months.
- Develop and submit a detailed draft Implementation Plan within 18 months and a final Implementation Plan within 3 months after receipt of comments from the Regional Board.
- Conduct Special Studies with the potential to revisit the TMDL within four years.

- Initiate implementation of non-structural source control measures dry weather flow management projects and, where feasible, wet weather structural source control measures.
- Reconsider TMDL based on Special Studies, other TMDLs and initial implementation measures within five years.
- Revise Implementation Plan based on any revisions to the TMDL within six years.
- Achieve dry weather compliance in the estuary within 6 years and interim dry weather compliance reductions to be established in the detailed Implementation Plan for inland reaches.
- Achieve incremental reductions in Exceedance days during wet weather within 10 years. Review progress of IRP approach to determine whether there is a need to consider implementation of any additional capture, treat and discharge elements.

While final compliance with Wet Weather exceedance day reductions at the mouth (wave wash) of Ballona Creek has already been established in the SMBB TMDL at 2020 based on an IRP approach, the CREST Steering and Technical Committees did not reach consensus on a final compliance date for the wet weather exceedance day allowances within the a) estuary and the fresh water reaches of Ballona Creek. Different views ranged from: 1) setting final compliance for the estuary and inland reaches/tributaries at the same date as the SMBB TMDL (December, 2020); or slightly less than 14 years from the assumed effective date of the Ballona Creek TMDL (March 2007); up to b) 18 years from the assumed effective date of the Ballona Creek TMDL, or March 2025, in order to fully implement and integrated, watershed approach. Additional interim compliance deadlines would depend upon the final deadline.

The SMB Beaches Bacteria TMDL is scheduled to be reviewed in 2007 to re-evaluate: 1) the allowable winter dry-weather and wet-weather exceedance days based on additional data from bacterial indicator densities in the wave wash; 2) the reference system selected to set allowable exceedance levels; and 3) the reference year used in the calculation of allowable exceedance days. It is proposed that the BC Bacteria TMDL be scheduled for re-consideration five years from the effective date of adoption to review the findings of any special studies. This re-evaluation will also include any revisions based on changes to the Santa Monica Bay Beaches Bacteria TMDL. Revising the TMDL will not create a conflict in the interim, since the Santa Monica Bay Beaches Bacteria TMDL does not require compliance during winter dry-weather or wet-weather until six and ten years, respectively, from the effective date of the TMDL. Therefore, the allowable exceedance days for winter dry-weather and wet-weather established in the TMDL can be reviewed and revised as necessary before the compliance deadline.

Cost Estimates for Implementation Strategies

Two implementation cost estimates were developed. The first is for the “Preferred Strategy” which takes a holistic view of regional water resources by integrating TMDL compliance with planning focused on beneficial re-uses of stormwater and other multiple purpose goals. While this is the preferred strategy based on the summary of all the objectives, it is also more challenging to predict implementation costs as it relies to a much greater degree on distributed, watershed-wide multi-objective solutions, the majority of which will require partnerships with private landowners, residents and businesses, and other public landowners (e.g., school districts) that are not directly responsible for TMDL compliance. Therefore, the cost estimate attempts to account for a range of economic factors and requires a number of assumptions regarding the extent and cost of implementing many of the measures. The alternative, “single-purpose” strategy of capture, treat and return and/or reuse is based primarily on larger, less distributed regional or subregional structural approaches that focus principally on end-of-pipe bacteria reduction.

The following sections describe how the costs were derived for the various components of both strategies. Following the description, a summary of the costs for each strategy is presented.

Components of Preferred Strategy that have been included in the cost are:

- Aggressively implementing a suite of source control strategies and institutional solutions to reduce dry weather flow (including smart irrigation) and reduce bacteria from both dry and wet weather flows.
- Installing cisterns at schools and government facilities to treat wet weather flows.
- Installing neighborhood recharge facilities in open spaces to treat dry and wet weather flows.
- Installing Infiltration Sand Filters to treat dry and wet weather flows.
- Retrofitting the NOTF to treat (disinfect) and discharge (return) dry weather flow and further treat up to 4 cfs of dry weather flow for indirect reuse; and treat additional wet weather flow not otherwise diverted or captured with watershed-based solutions.
- Diverting any remaining dry weather flows from downstream watersheds to treatment plants.
- No costs are directly included for stream restoration/Creek daylighting as this concept has not been developed sufficiently to assign costs; but, this would be a concept that would be further explored.

The components of the Alternative Strategy include:

- Aggressively implementing a suite of source control strategies and institutional solutions to reduce dry weather flow (including smart irrigation) and reduce bacteria from both dry and wet weather flows.
- Diverting all dry weather flows to the wastewater system for treatment at the Hyperion Treatment Plant.
- Constructing a new treatment plant to temporarily store, disinfect, and discharge flows from the Upper Watershed (Proposed Treatment Plant 1).
- Constructing a new treatment plant built at a point downstream of flow coming from West L.A. and Westwood Village Watersheds to temporarily store, disinfect, and discharge flows (Proposed Treatment Plant 2).
- Constructing a new treatment plant built at point downstream of flow coming from Winsow Hills Watershed (Centinela Creek) to temporarily store, disinfect, and discharge flows (Proposed Treatment Plant 3).

In reviewing these cost estimates, it should be noted that there are multiple benefits associated with the implementation of the dry and wet weather solutions under the Preferred Strategy. Many of the BMPs (both source and treatment control approaches) would also have the ability to reduce the amount of other contaminants in the runoff, which could assist in meeting the requirements of other Ballona Creek existing and emerging TMDLs, such as the Metals, Toxics, and Trash TMDLs. For example, infiltration trenches with a gross solids removal system would remove metals and trash from the runoff as well as indicator bacteria.

Institutional Flow and Bacteria Source Control Costs

Institutional source controls are measures that seek to reduce either the total flow or the amount of bacteria entering Ballona Creek and are assumed to be applicable and appropriate for implementation under either strategy. As these source controls are on an institutional level, the actual volume or concentration of bacteria that will be reduced cannot be accurately or precisely quantified. In the future, when these types of programs are implemented, a quantifiable correlation will likely be performed but it is not available at this time. For the purposes of reasonable assurances to compliance with WQS, it has been estimated that dry weather flows will be reduced by at least 25% through these measures.

Bacteria Source Control

A number of similar source control measures were already identified in the Ballona Creek Metals TMDL, with costs based on the entire Los Angeles Region, which has an area of 3,100 square miles. As the Ballona Creek Watershed is 128 square miles, the control measure costs were scaled down proportionally. The following represent the approximate values for these source control measures in the Ballona Creek Watershed:

- Enforcement of litter ordinances - \$0.4 million per year;
- Public education - \$0.2 million per year;
- Improved street cleaning - \$0.3 million per year;
- Increased Storm Drain Cleaning - \$1.1 million per year.

In addition to these source controls identified in the Metals TMDL, an estimated \$1 million per year was added for additional bacteria source control measures such as finding and eliminating hot spots, sewer overflows, and other sources of elevated bacteria that may affect either dry or wet weather flows. Together, this equals a total estimated annual cost of \$3 million per year, much of which can be shared with other TMDL (Metals and Toxics) implementation requirements.

Summary:

- Capital costs: NA;
- Operation and Maintenance Costs: \$3 million (M)/yr.

Institutional Flow Source Control

“Smart Irrigation” refers to the use of irrigation controllers to monitor irrigation, based on actual weather data and soil moisture content using evapotranspiration (ET) controllers. In addition to reducing the amount of water use, the units would also reduce or eliminate over-watering, a significant contributor to dry weather runoff.

The City of Los Angeles IRP looked at studies being done in both the City and by the Irvine Ranch Water District (IRWD). Based on the findings described in the IRP, effectiveness rates of installing the devices at various land uses were determined as well as the costs for implementing these devices.

The IRP estimated that ET controllers could be installed at 70% of land uses throughout the City. The land use data presented in Table 5 shows the residential and commercial acreage in the Ballona Creek Watershed.

Land Use	Area (acres)
High Density Residential	45,600
Low Density Residential	2,950
Mixed Urban	100
Commercial	12,950
Industrial	4,200
Open Space	14,000
Other	2,200
Total	82,000

Source: Ballona Creek Metals TMDL Land use data.

Table 6 presents the estimated runoff reduction from employing Smart Irrigation. As shown in the table, the runoff rate (as determined by the IRP) was multiplied by 70% of the total area for residential and commercial properties. This runoff amount was multiplied by the effectiveness rate of ET controllers in reducing this runoff amount for each land use shown. Finally, the calculation shows that runoff could be reduced by 3 million gallons per day (mgd) by implementing Smart Irrigation.

	High Density Res.	Low Density Res.	Commercial	Total
Area (acres)	45,600	2,950	12,950	61,500
70% of area implementing S.I. (acres)	31,920	2,065	9065	43,050
Runoff Coefficient (gpd/ac) ¹	230	230	230	NA
Total Runoff (mgd):	7.3	0.5	2.1	10
% Effectiveness of Smart Irrigation (%) ²	30%	71%	20%	NA
Total Runoff Reduction (mgd) ³	2.2	0.3	0.4	3.0

Notes:

¹ The Runoff coefficient is for the Ballona Creek Watershed as determined in the IRP.

² The % effective is the effectiveness of the Smart Irrigation device at reducing the amount of runoff for a given land use and is based on IRP Smart Irrigation analysis, which was based on Irvine Ranch Water District pilot project data.

³ Total Runoff Reduction is the total runoff multiplied by the % effectiveness of the devices.

Assuming ET controllers were installed in 70% of all properties, a total area of about 43,000 acres would be targeted for controllers. While there would be a wide range of densities and lot sizes for both single- and multi-family residential properties, for cost estimating purposes an average of one controller per acre was assumed, with a particular emphasis on larger properties. Therefore, the estimated cost is based on installing up to 43,000 units. At a cost of \$175 per device (which includes installation), the total capital cost would be \$7.5 million.

For an ET controller to operate, it must receive a satellite signal that controls the amount of irrigation that occurs. The monthly cost for this is \$4 per device. With up to 43,000 devices installed, the annual operation and maintenance cost would be about \$2 million per year.

Since these devices will reduce the amount of potable water demand that each residence or commercial facility uses for irrigation, these users will have a significant savings in potable water purchasing costs. As such, the capital and/or long-term operation and maintenance and replacement costs could be borne by the individual user rather than the municipalities of the Ballona Creek Watershed.

It should be noted that this approach could over-estimate the reduction of runoff since the number of real estate properties with underground irrigation systems and automatic controllers is unknown. In addition, future implementation would depend on available funding, customer acceptance, reliability, and commercial availability of Smart Irrigation controllers. More detailed studies would be needed to determine the full benefits of a smart irrigation program.

Summary:

- Capital costs: \$7.5M;
- Operation and Maintenance Costs: \$2 M/yr.

Structural Flow Source Control Costs

Cistern Costs

For developing a cost estimate for the cisterns component, it is assumed that cisterns will be installed only at schools and government facilities, since these types of controls are more easily implemented on these land uses, as opposed to at private homes, commercial properties, etc. Programs to promote and assist in providing cisterns for private residential development (single or multifamily) would be encouraged but specific costs are not included in this estimate.

For schools and government facilities, it was assumed that a similar percentage of city-wide implementation as was used in the IRP would apply to Ballona Creek. As shown in the IRP, which used Southern California Association of Governments (SCAG) land use data, schools and government facilities cover 3% of the total area of the City of Los Angeles. Using the same percentage for the Ballona Creek Watershed which is 82,000 acres, the resulting area for schools and government facilities in the Ballona Creek Watershed is 2,500 acres.

Additionally, the IRP estimated that 10,000 cisterns would be required to treat a target volume of 80 MG. As shown in Table 7, these values were used to determine the proportional amount that Ballona Creek Watershed would require.

Land use	LA IRP	Ballona Creek Watershed
Total Area (acres)	295,000	82,000
Area of Schools/Gov. Facilities (acres)	9,200	2,500
Runoff Target Volume ¹	80	14
Number of 10,000 Gallon Cisterns Required ^{2,3}	10,000	2,260

Note:

- ¹ Runoff coefficient = 0.47 (per Watershed Protection Division Pollutant Load Model)
- ² Cisterns are assumed to be 10,000 gallons, as determined by the IRP. In the IRP, 50 years of rainfall data was analyzed to estimate what size cistern would be required to manage all of the flow from these land uses. Though actual size would be determined on a site by site basis, for the purposes of cost estimation an average size of 10,000 gallons is assumed.
- ³ The number of cisterns needed for Ballona Creek Watershed (BCW) at schools and government facilities was determined on a percentage basis using the average of the % by area and % by flow volume. (BCW has 18% of the flow from schools/government that the entire City of LA has, and 28% of the area. The average is 23% which is used here).

Based on the data shown in Table 7, up to 2,260 cisterns could be installed in the Ballona Creek Watershed to manage the flow from all schools and government facilities. With a unit cost of \$1/gallon as estimated in the City of Los Angeles IRP, for the 10,000 gallon

cisterns the total cost would be: \$1/gallon * 10,000 gallons/cistern * 2,260 cisterns = \$22.6 million.

Operation and maintenance costs for cisterns are based on the amount of water pumped. In order to estimate these costs, the volume of water, size of pump, and energy costs were assumed. In the cistern analysis done for the IRP (referred to in Note 2 of Table 4), 50 years of rainfall data were analyzed to estimate the size of cisterns that would be required to manage the flows for these land uses for these rainfall amounts. In addition to determining that the 10,000 gallon cistern would, on average be the appropriate size, it was determined that approximately 70,000 gallons per year of runoff would be captured by each cistern. Additional assumptions include:

- 3 horsepower pump;
- Flow rate of 10 gallons per minute;
- Unit energy cost of \$0.10 per kilowatt-hour.

Using the standard equation of $W = \text{Power} * \text{Volume} / \text{Flow}$, which for these assumptions is:

$$W = (3\text{hp}) * (.745\text{kW}/\text{hp}) * (70,000\text{gal}/\text{yr}/\text{cistern}) / ((10\text{gal}/\text{min}) * (60\text{min}/\text{hr})) = 261 \text{ kW-hr}/\text{cistern}/\text{yr}$$

For 2,260 cisterns and using an energy cost of \$0.10 per kilowatt-hour, the total operation and maintenance cost for electrical power is \$0.06 M/yr. A total O&M cost of \$0.2 per mgd was assumed to allow for other operation, maintenance and replacement costs.

Summary:

- Capital costs: \$22.6M;
- Operation and Maintenance Costs: \$0.2 M/yr.

Neighborhood Recharge Costs

The concept of “neighborhood recharge” is based on developing local, on-site or subwatershed-based projects in parks, public land, vacant property, and other open spaces within the Ballona Creek Watershed. As shown in Table 3 above, the area of open space in Ballona Creek Watershed not located in the hills is estimated at 7,500 acres. Although substantial portions of the remaining 7,500 acres watershed would include areas where soils are poor for infiltration, where land use is not compatible or otherwise committed to other uses, or areas are unsuitable for other reasons, it was estimated that up to 5 percent of the remaining 7,500 acres of open space might be suitable for neighborhood recharge. This results in the potential to develop up to 375 acres of land for some form of neighborhood recharge. The types of projects could vary significantly, but would generally focus on multiple benefits including water quality improvements, water conservation (either reduced water use or local recharge), and potentially recreational/aesthetic benefits.

It was also estimated that in the areas where neighborhood recharge would be installed, a relatively moderate infiltration rate of 0.5 ft/day could be achieved since the soils in much of the coastal area are much less suitable for significant infiltration (per Los Angeles County DPW Hydrology Manual). Any recharged initiated water would help with maintaining local groundwater levels. Using this infiltration rate and the 375 acres of land, an estimated 61 mgd could be managed by implementation of neighborhood recharge projects.

For the IRP, a unit cost of \$0.65 M/ac was assumed based on data developed under the Sun Valley Project. Therefore, the total estimated capital cost for full implementation of this concept could be as high as \$244 million.

For operation and maintenance costs, information from the Sun Valley project was used to develop an average operation and maintenance cost for similar local/neighborhood recharge facilities of approximately \$3,000/ac/yr. This would result in approximately \$1.1 M/yr in operation and maintenance costs for 375 acres of neighborhood recharge facilities.

Summary:

- Capital Costs: \$244 M;
- Operation and Maintenance Costs: \$1.1 M/yr.

Sand Filters and Infiltration Trenches Costs

An additional implementation method included was implementation of sand filters or infiltration trenches in local watersheds, which is also being considered for the Ballona Creek Metals TMDL. Sand filters are specifically designed to treat urban runoff in high density areas, and are proposed as part of the implementation strategy to address the Ballona Creek Metals TMDL. In the Metals TMDL, these BMPs were selected in part due to the fact that they can also remove bacteria. USEPA reports that sand filters have a 76% removal rate for fecal coliform (USEPA, 1999c). These BMPs have the additional positive impact of addressing the effects of development and increased impervious surfaces in the watershed, and both approaches can be designed to capture and treat at least 0.5 to 1 inch of runoff. Additional flow exceeding the design capacity would be allowed to bypass the device and enter the storm drain untreated. The device could also manage the entire dry weather flow.

Sand filters must be used in conjunction with a pretreatment device such as a biostrip or gross solids removal device to remove sediment and trash in order to increase their efficiency and service life. As stated above, these devices would then have the combined effect of achieving compliance with the Metals TMDL and the Trash TMDL as well as the Bacteria TMDL. The cost analysis was done for the Trash and Metals TMDLs, as shown below, and accounts for the gross solids removal systems, including structural vortex separation systems and end of pipe nets, as well as the costs associated with installing sand filters.

The Metals TMDL assumed that sand filters would treat 20 percent of the urbanized portion of the watershed. Costs were estimated by using data provided by USEPA (USEPA, 1999a and 1999c) in 1997 dollars, and the Federal Highway Administration (FHWA, 2003) in 1996 dollars for infiltration trenches and 1994 dollars for sand filters. Where costs were reported as ranges, the highest range was assumed. These costs were then compared to Caltrans' costs determined in their BMP Retrofit Pilot Program (Caltrans, 2004) that were reported in 1999 dollars. Refer to Appendix A of the Ballona Creek Metals TMDL for the cost analysis and sizing constraints.

Since the 0.45-inch storm event, rather than the 0.5 inch storm, was used to develop this analysis, an adjustment was made to determine 20% of this flow. As was determined by the EPA/Tetra Tech flow model, the total flow from the 0.45 inch storm for this area is 544 MG per event. Therefore, 20 percent of this flow is 109 MG per event, which is what would be managed with sand filters.

For this TMDL, a unit cost for the sand filter was determined using the cost data provided in the Metals TMDL and estimating the runoff from the 0.5 inch storm event that these costs were based on. Taking the 109 MG/event that the sand filter would manage, the total capital and O&M costs were calculated as shown in table 8.

Sand Filters	From Metals TMDL (0.5 in rainfall)					For 20% of flow from 0.45 inch storm event	
	Capital Costs (\$M) ¹	O&M Costs (\$M/yr) ¹	Flow Managed (MG/event) ²	Unit Capital Cost per MG (\$M/MG) ²	Unit O&M Cost per MG (\$M/MG/yr) ²	Total Capital Costs (\$M) ³	Total O&M Costs (\$M/yr) ³
	88.00	4.00	120.93	0.73	0.03	\$79	\$3.60

Note:

¹ Source: Ballona Creek Metals TMDL - for columns 2,3,4. All other columns calculated based on this data and flow from 0.45-inch storm event. These costs are the average of USEPA and FHWA Estimates that were presented in the Metals TMDL. FHWA did not report O&M data, so O&M data shown in from USEPA only. Only Delaware sand filters are presented as they are used from smaller drainage areas (approx 1 acre) as opposed to 50 plus acres.

² Flow managed in this column is based on Metals assumptions listed and IRP values. Unit costs calculated based on this flow and the total costs in columns 2 and 3.

³ Total capital and O&M costs based on, which is 47 MG/event.

Summary:

- Capital Costs: \$79 M;
- Operation and Maintenance Costs: \$3.6 M/yr.

Dry Weather Diversion Costs

This component involves diverting any remaining dry weather runoff that has reached the storm drain system to the wastewater collection system for treatment at the Hyperion Treatment Plant (HTP). The Cities of Los Angeles and Santa Monica have already initiated diversion programs on most of the storm drains discharging to the Santa Monica Bay Beaches. Based on the actual costs associated with these diversions, a unit cost per mgd of diversion capacity was estimated to be approximately \$1.2 million. Adding on 30

percent to account for non-construction costs including project management, design, construction management, startup, etc., the unit capital cost of \$1.6 million per mgd was assumed.

For the two strategies discussed, different amounts of dry weather runoff would require diversion. According to the Preferred Strategy, only dry weather flows downstream of the North Outfall Treatment Facility that would not be managed by source controls or other watershed-based BMPs, would be diverted. This is estimated to be a peak flow total of about 7.8 mgd, which results in a capital cost of approximately \$12 million. According to the Alternative Strategy, all of the dry weather runoff that is not already reduced through source controls would be diverted (an estimated peak flow of 19.7 mgd), which would result in a capital cost of \$31 million.

Operation and maintenance costs are also taken from the constructed dry weather low flow diversions as presented in the IRP, using a unit operation and maintenance cost of about \$34,000/mgd/yr. Using an average of 4 mgd of diverted flow for the Preferred Strategy, the total operation and maintenance cost estimate is \$0.13 M/yr. For the Alternative Strategy, with an average flow of approximately 19.7 mgd diverted, the total operation and maintenance cost would be \$0.32 M/yr.

Summary:

- Capital Costs: \$12.1 M (Preferred Strategy); \$31 M (Alternative Strategy);
- Operation and Maintenance Costs: \$0.11 M/yr (Preferred Strategy); 0.32 M/yr (Alternative Strategy).

Treatment and Discharge/Reuse Costs

The following runoff capture and treatment facilities are included in the costs:

- Retrofit North Outfall Treatment Facility (NOTF) to treat dry and wet weather runoff, with reuse of up to 4 cfs of dry weather runoff (Preferred Strategy).
- Install New Urban Runoff Treatment Plant in Upper Watershed (Alternative Strategy).
- Install Urban Runoff Treatment Plant at West Los Angeles Subwatershed (Alternative Strategy).
- Install Urban Runoff Treatment Plant at Windsow Hills Subwatershed (Alternative Strategy).

The following dry weather flow data represents the maximum dry weather flow rate:

- North of NOTF = 23 cfs = 15 mgd;
- Sepulveda & West LA = 7 cfs = 5 mgd;
- Centinela = 5 cfs = 3 mgd;

- Total = 35 cfs = 23 mgd.

The following wet weather flow information was determined based on an EPA/Tetra Tech flow modeling program to manage up to a 0.45 inch storm event. These data are also presented in Figure 3.

Subwatershed flows:

- Hollywood Subwatershed: 247 cfs;
- Cienega: 164 cfs;
- Windsow Hills: 77 cfs.

Flows within Ballona Creek:

- Approx. at NOTF: 439 cfs;
- At Westwood Village Subwatershed: 447 cfs;
- At West LA Subwatershed: 765 cfs;
- Runoff Volume from a single storm event: 471 MG = 1,445 AF.

Retrofit NOTF to Treat Dry and Wet Weather Runoff, with Reuse of up to 4 cfs of Dry Weather Runoff

Part of the Preferred Strategy includes retrofitting the existing NOTF. A study was done for the City of Los Angeles Bureau of Engineering in 1995 entitled *Ballona Creek Treatment Facility Feasibility Study and Preliminary Design (Study)*. This study estimated the costs associated with retrofitting the NOTF, which is currently not in use as a wet weather sewer overflow facility, yet has the capability to capture, store, treat, disinfect and discharge urban runoff. One of the alternatives analyzed included treating dry weather runoff and a fraction of wet weather runoff and reusing a portion of the dry weather runoff. Costs were presented for two different amounts of reuse, and the costs shown below represent an interpolation of the two to meet the reuse target of 4 cfs.

The feasibility study examined converting the existing NOTF, with a maximum capacity of approximately 150 cfs (97 mgd), for solids reduction and disinfection sufficient to achieve REC-1 standards in the discharge. The NOTF also has 1 MG of storage available without additional construction. Using a typical hydrograph presented in the *Study*, the 1 MG of storage could manage an additional 19 cfs (12 mgd). Therefore, the wet weather total flow that could be managed at the retrofitted NOTF is 109 mgd. Under the Preferred Strategy, if a full suite of non-structural and structural source control measures are ultimately developed across the upper subwatersheds, the combination of implementing source control measures and projects and making use of conversion of existing facilities at the NOTF make it possible to manage sufficient flow to meet the TMDL target for the upper watershed, as well as provide a significant source of treated dry weather flow for reuse.

By updating study costs to current (2005) values, the capital costs for constructing diversion facilities into the plant, retrofitting the plant for treatment and discharge, and constructing additional facilities to provide water of sufficient quality for unrestricted non-potable reuse of up to 4 cfs (2.6 mgd) of dry weather runoff, is estimated to be approximately \$9 million. Operation and maintenance costs are estimated to be approximately \$0.9 million per year (adjusted for inflation). Neither the capital nor the operation and maintenance costs include any reuse distribution costs. Conversely, the cost estimate does not include any "revenue" that could be realized from potential sale of the recycled water. For example, assuming the project could produce up to 2,900 acre-ft of water, the potential "value" of the water is up to \$1.4 M at \$500/ac-ft.

Summary:

- Capital Costs: \$9 M;
- Operation and Maintenance Costs: \$0.9 M/yr.

Construct Urban Runoff Treatment Plant in the Upper Watershed (Plant 1)

Under the Alternative Strategy, one new urban runoff treatment plant is assumed to be constructed, with sufficient storage and capacity to serve the upper watershed (approximately the same portion of the watershed as is tributary to the vicinity of the existing NOTF). The watershed flows at this point are approximately 440 cfs, as shown in Figure 3. In order to analyze the flows, the hydrograph from the NOTF *Study* discussed above was used. This hydrograph, which is Figure 2-5 of that document, is for a comparable flow (470 cfs at its peak²); and therefore, this hydrograph was assumed to be comparable. This hydrograph shows that the average flow is approximately 250 cfs for a duration of 2 hours. Using these data, and assuming that 150 cfs (97mgd) would be treated instantaneously, the storage required to treat this entire 437 cfs (284 mgd) was calculated as follows:

- Storage required = $(250\text{cfs}-150\text{cfs}) * 3600 \text{ sec/hr} * 2 \text{ hrs} * 7.48 \text{ gal/cf} / 1\text{M gal/MG} = 5.4 \text{ MG}$.

The unit cost of \$4.7 M/mgd that was used in the IRP resulted in a total treatment plant cost (including land acquisition) of $97 \text{ mgd} * \$4.7 \text{ M/mgd} = \456 M . The cost for building additional temporary storage was calculated based on the unit costs shown in the IRP of \$1.30M/MG of storage capacity. For the 5.4 MG of storage, the total cost would be \$7 million. In addition, a lump sum cost for collection and discharge pipelines was included at \$50 million. The total capital cost is therefore estimated at \$512 million.

Operation and maintenance costs were estimated based on the information presented in the *Study*. These costs included the following:

² Flow from hydrograph metered at Sawtelle Blvd., determined to be within 2% of flow at BCTF and negligible for the purposes of this study.

- Power: \$0.20 million/yr;
- Labor: \$0.25 million/yr;
- Chemicals: \$0.01 million/yr;
- General Maintenance: \$0.07 million/yr.

This results in a total unit cost of \$0.53 million per year in operation and maintenance costs.

Summary:

- Capital Costs: \$512 M;
- Operation and Maintenance Costs: \$0.53 M/yr.

Construct Urban Runoff Treatment Plant at West Los Angeles Subwatershed

Construction of a new treatment plant built at a location north of Ballona Creek, downstream of flow coming from West LA and Westwood Village subwatersheds is for Alternative 2 only. At this point in Ballona Creek, the flow is 326 cfs. For developing cost estimates, it was assumed that a treatment plant constructed with a capacity of 100 cfs would be built. With this assumption, a proportionally scaled down version of the hydrograph as shown in the *City of LA BOE Ballona Creek Treatment Facility Feasibility Study and Preliminary Design* document was used to estimate the amount of storage needed. From this scaled down hydrograph, an average flow of 175 cfs, with a duration of 2 hours resulted in the following storage required to treat the entire 326 cfs (210 mgd) of flow in a 100 cfs (65 mgd) treatment plant:

- Storage required = $(175\text{cfs}-100\text{cfs}) * 3600 \text{ sec/hr} * 2 \text{ hrs} * 7.48 \text{ gal/cf} / 1\text{M gal/MG} = 4 \text{ MG}$.

To determine the cost associated with constructing this plant, again, unit cost estimates from the IRP were used. The unit cost of \$4.7 M/mgd resulted in a total treatment plant cost (including land acquisition) of 65 mgd * \$4.7 M/mgd = \$304 M. The cost for building additional temporary storage was calculated based on the unit costs shown in the IRP of \$1.30M/MG of storage capacity and a 4 MG tank is estimated at approximately \$5.3 M. Additionally, collection pipelines and discharge pipelines were assumed to be a lump sum of \$40 M. The total cost is then \$349 M.

Using a similar approach to operation and maintenance costs, the unit cost per cfs would be: \$0.53 M/yr divided by 150 cfs = \$3,530 /yr. Adjusted for the 100 cfs treated at this site, the total operation and maintenance costs would be approximately \$0.35 M/yr.

Summary:

- Capital Costs: \$343 M;
- Operation and Maintenance Costs: \$0.35 M/yr.

Construct Urban Runoff Treatment Plant at Windsow Hills Subwatershed

This treatment plant would be constructed at point south of Ballona Creek to intercept flow coming from Windsow Hills subarea (Centinela Creek). At this point in Ballona Creek, the estimated target flow is 77 cfs. It is assumed that a treatment plant designed to treat 25 cfs would be built, and with this assumption, a proportionally scaled down version of the aforementioned hydrograph as shown in the *Study*, with an average flow of 40 cfs and a with a duration of 2 hours, the resulting storage required to treat the entire 77 cfs (50 mgd) of flow in a 25 cfs (16 mgd) treatment plant would be:

- Storage required = $(40\text{cfs}-25\text{cfs}) * 3600 \text{ sec/hr} * 2 \text{ hrs} * 7.48 \text{ gal/cf} / 1\text{M gal/MG} = 0.8 \text{ MG}$.

To determine the cost associated with building this plant, unit cost estimates from the IRP were used. The unit cost of \$4.7 M/mgd resulted in a total treatment plant cost (including land acquisition) of $16 \text{ mgd} * \$4.7 \text{ M/mgd} = \75 M . The cost for building additional temporary storage was calculated based on the unit costs shown in the IRP of , \$1.3 M/MG, which for the 0.8 MG tank is \$1.1 M. Additionally, collection pipelines and discharge pipelines were estimated to be a lump sum of \$10.0 M. The total capital cost is then estimated at approximately \$87 M.

Using a similar approach to O&M costs as previously presented, the unit cost per cfs would be: $\$0.53 \text{ M/yr} \text{ divided by } 150 \text{ cfs} = \0.00353 M/yr . Adjusted for the 25 cfs treated here, the total operation and maintenance costs would be \$0.09 M/yr.

Summary:

- Capital Costs: \$82 M;
- Operation and Maintenance Costs: \$0.09 M/yr.

In-stream Solutions

“In-Stream Solutions” represent a range of potential approaches which may include “daylighting” of segments of tributary reaches that are currently underground storm drain systems, and restoring natural habitat along an existing stream segment (tributary or main stem) in a reach that is currently fully lined, which is typical of nearly all of inland Ballona Creek and it’s tributaries. Under this concept, the restoration or daylighting project concept would be undertaken to provide multiple benefits, one of which would be to optimize the ability of the restored reach to provide in-stream or off-stream bacteria reduction. This would be primarily targeted at reducing bacteria in dry weather flow.

Summary and Discussion

The following two tables identify the total cost estimates for the Preferred Strategy (Table 9) and the Alternative Strategy (Table 10).

While the summary tables mentioned above present an initial range of potential costs for the two different strategies based on the assumptions previously noted in the discussions on individual components, there are several key observations to note with respect to the cost estimates.

- Costs for the integrated approach are based on a limited number of potential “options” to keep the cost approach simplified. In reality there will likely be other opportunities that may be identified over time that afford both water quality improvement and other multiple benefits that may be implemented
- The estimated capital costs for full implementation of potential neighborhood recharge projects represent over 60% of the total estimated cost. Conversely while the relative contribution to reduction in wet weather flow and therefore presumed reduction in bacteria contribution, is estimated at slightly greater than 10% of the wet weather flow. This results, in part, from extending cost estimates from a limited base of projects and also accounting for generally lower effective recharge capabilities within the coastal watersheds. As implementation of projects and programs progresses, it is anticipated that the responsible agencies will focus first on the projects with highest potential return wherever possible, evaluate results, and attempt to optimize the overall program effectiveness and costs. Therefore, it is possible that close to similar levels of bacteria reduction could potentially be achieved with substantially less capital and associated operation and maintenance costs. Conversely, there are a number of assumptions contained in the cost estimates that could ultimately result in greater capital or operation and maintenance costs for other components to achieve full compliance.
- The cost estimates indicate that the Preferred Strategy has the potential for significantly lower (though still major) capital costs compared to the Alternative Strategy, but higher operation and maintenance costs. These two strategies were not compared on a present worth or equivalent annual cost basis as this was not intended to be a full economic analysis with selection based on cost estimate. These two options simply represent different overall approaches that can be considered. The direction from CREST to focus on the Preferred Strategy was based on a number of considerations rather than primarily costs.
- Most of the program components included in the Preferred Strategy would be effective at helping reduce multiple pollutants, in particular metals and possibly trace toxic substances. Therefore, as implementation plans progress for all TMDLs in the watershed, close coordination between efforts is warranted, and the total cost of compliance with all TMDLs has the potential to be significantly less than the sum of the individual costs estimated for each TMDL.

**Table 9
 Preferred Strategy Summary Table**

Option	Average Dry Weather Flow Managed (cfs)	Volume of Wet Weather Flow Managed (MG/event)	% of Dry Weather Flow Managed	% of Wet Weather Flow from 0.45 inch storm ¹	Capital Cost (\$M)	O&M Cost (\$M/yr)
Non-Structural Flow Source Controls ²	4.7	NA	25%	NA	\$8	\$2.07
Bacterial Source Control						\$3.00
Cisterns	NA	14	NA	3%	\$23	\$0.06
Neighborhood Recharge	1	61	5%	11%	\$244	\$2.63
Sand Filter	1.3	109	7%	20%	\$79	\$3.60
Dry Weather Diversions	5	NA	26%	NA	\$12	\$0.26
NOTF (reuse plus discharge)	7	99	37%	18%	\$9	\$0.84
Total	19	283	100%	52%	\$375	\$12.46

¹ The % of total wet weather flow is based on the total wet weather flow from the 0.45-inch storm for Ballona Creek at West LA subwatershed point plus the flow from Windsow Hills (i.e., 765 cfs+77cfs=842dfs = 544 mgd).

² Non-structural source controls include institutional solutions and smart irrigation implementation.

**Table 10
 Alternative Strategy Summary Table**

Component	Average Dry Weather Flow Average Managed (cfs)	Volume of Wet Weather Flow Managed (MG/ event)	% of Dry Weather Flow Managed	% of Wet Weather Flow from 0.45 inch Storm. ^{1,2}	Capital Cost (\$M)	O&M Cost (\$M/yr)
Non-Structural Source Controls ³	4.7	NA	25%	13%	\$8	\$5.07
Dry Weather Diversions	14.3	NA	75%	87%	\$31	\$0.66
Proposed Wet Weather Treatment Plant 1	NA	284	NA	52%	\$453	\$0.53
Proposed Wet Weather Treatment Plant 2	NA	211	NA	39%	\$343	\$0.35
Proposed Wet Weather Treatment Plant 3	NA	50	NA	9%	\$82	\$0.09
Total	19	545	100%	100%	\$917	\$6.7

Notes:

¹ The % of flow for dry weather is the percent of the total Dry Weather flow that is managed through diversions.

² The % of total wet weather flow is based on the total wet weather flow from the 0.45-inch storm for Ballona Creek at West LA subwatershed point plus the flow from Windsow Hills (i.e., 765 cfs+77cfs=842dfs = 544 mgd).

³ Non-structural source controls include institutional solutions and smart irrigation implementation.

Monitoring Program

Monitoring Program Objectives

The monitoring program for the Ballona Creek bacteria TMDL has the following objectives:

- Provide data and information to build a baseline of current conditions and support the effectiveness of components of the implementation plan (pre-compliance (or ambient) and effectiveness monitoring);
- Verify effectiveness of the implementation strategy in meeting the water quality objectives for the listed water bodies (“compliance monitoring” as defined in the SMBB TMDL, or “effectiveness monitoring” as defined in the Ballona Creek Metals TMDL);
- Provide information useful for possible future revisions to the TMDL plan (e.g., special studies_).

Responsible jurisdictions are encouraged to use similar monitoring locations and timing in Ballona Creek and/or Ballona Creek Estuary where feasible to conduct compliance monitoring for both the Bacteria TMDL and the Metals and Toxics TMDLs.

Pre-compliance or Ambient Monitoring

Existing monitoring efforts are expected to continue in the near term (could be considered “pre-compliance monitoring” once the TMDL is adopted), to help support the understanding of the effectiveness of components of the implementation plan as well as support trends that can potentially be transitioned into compliance monitoring programs when future dates are determined under the adopted TMDL. The existing monitoring efforts are currently conducted by the City and County of Los Angeles. Once the TMDL is adopted, potential cost sharing can be considered for continued monitoring that supports the TDML.

As noted above, wherever possible and appropriate, the TMDL monitoring program incorporates existing monitoring programs, and existing “baseline” databases of historical water quality and flow results in order to efficiently evaluate water quality conditions and trends. In addition, coordination with compliance monitoring conducted for other Ballona Creek TMDLs (e.g., Metals and Toxics) is encouraged.

Compliance (or Effectiveness) Monitoring

Under the current regulatory framework, monitoring in Ballona Creek watershed for the purposes of determining compliance with this Bacteria TMDL will need to be conducted at 1-2 locations in each of the 303(d) listed waterbodies (Reaches 1 and 2 of Ballona Creek, the Ballona Creek Estuary, and Sepulveda Channel) and potentially in other unnamed reaches in order to verify compliance with WQS. Details of a compliance monitoring program will be developed and submitted for approval during the first six months of TMDL implementation.

Design of the compliance monitoring program requires careful consideration of the planned implementation strategies for the Ballona Creek Bacteria TMDL. The Ballona Creek Bacteria TMDL implementation strategy was developed by stakeholders in the watershed, including cities, regulatory representatives, and representatives of environmental groups with an interest in the watershed. The preferred implementation alternative focuses on an integrated watershed-based program consisting of a variety of non-structural institutional and decentralized structural solutions to reduce flow to and bacteria concentrations within Ballona Creek, as opposed to heavily engineered structural “end-of-pipe” solutions such as large-scale diversion and treatment. Stakeholders favored the preferred alternative, which addresses a broad range of long-term planning goals for the watershed for reducing bacteria concentrations because of the integrated water resources approach and the multiple benefits this alternative provides for the watershed. Accordingly, monitoring programs that are flexible and adaptable to measure the total resource benefits as well as the water quality benefits is consistent with and complements the direction of CREST.

A compliance monitoring program is intended to verify compliance with water quality standards at specific locations within the 303(d)-listed reaches. For Ballona Creek, it is anticipated that at least one location within each of the listed reaches (Reach 1, Reach 2, Estuary and Sepulveda Channel) will be monitored for TMDL compliance (bacteria water quality compared to exceedance day allowance); other site locations may be required by the Regional Board and will be determined during the development of the Monitoring Plan. Such monitoring would include either daily (in the estuary) or systematic weekly sampling. Exact locations and methodology for sampling will be defined in a detailed monitoring plan to be submitted by responsible jurisdictions to the Regional Board for approval. Samples from the estuary will be analyzed for *E. coli*, *Enterococcus* and total coliform and in the inland reaches for *E. coli* (including Reach 2 with *E. coli* as a surrogate for fecal coliform). Sampling in the impaired reaches for compliance determination during dry and wet weather conditions will begin in accordance with the Implementation Schedule shown in the previous section.

Indicator bacteria analyses for compliance monitoring of the impaired reaches will be conducted in accordance with the applicable water quality objectives as follows:

- Ballona Creek Estuary – *E. coli*, *Enterococcus*, fecal coliform, total coliform; ratio of fecal coliform to total coliform.
- Ballona Creek Reach 2 and Sepulveda Channel – *E. coli*, fecal coliform;
- Ballona Creek Reach 1 – fecal coliform (or *E. coli* with an approved translator).

It is possible that *E. coli* can serve as the primary surrogate indicator in all reaches at the choice of the responsible agencies, using an appropriate *E. coli* to FC ratio translator. In addition, to enhance understanding of bacteria sources in the watershed, responsible jurisdictions conducting compliance monitoring are encouraged to analyze collected water samples for indicator bacteria other than those defined in water quality objectives. For instance, analysis of *Enterococcus* in Reach 2 could be used to quantify by difference the magnitude of loading from sources that originate in the downstream Estuary.

Special Studies

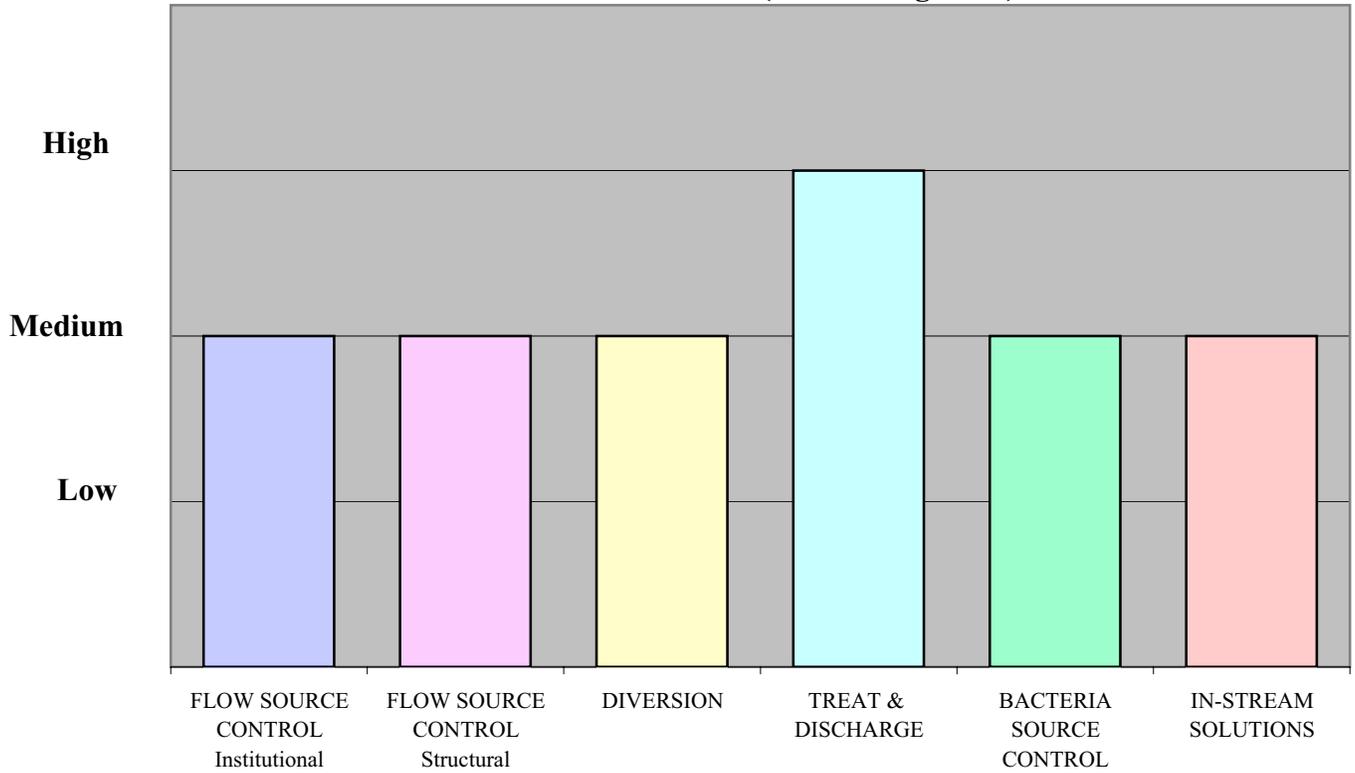
It is expected that responsible jurisdictions and agencies within the watershed may conduct monitoring and study efforts (special studies) designed to address specific questions that may either serve to help refine or revise the TMDL at future dates, or assist with TMDL implementation and adaptive management such as source characterization/identification, and measurement of BMP effectiveness. Specific studies that may provide information for possible future TMDL revisions or updates include:

- Monitoring an inland reference watershed to quantify the loading of indicator bacteria from background/natural sources (in conjunction with and/or support of others (e.g., the Southern California Coastal Water Research Project).
- Source characterization.
- Water quality modeling to better define the effectiveness of implementation strategies.
- Characterizing the hydrodynamics in the Estuary and the relationship of Ballona Creek water quality and tidally-influenced flows; potentially including a determination of the most appropriate monitoring location/depth, the effect of the estuarine environment on bacteria moving through the Estuary; and the relative effectiveness of diverting upstream dry weather flows.
- Analyses and studies to evaluate unintended impacts (i.e. minimum flow to creek) when implementing BMPs and other implementation strategies. Investigating potential impact to biological resources in Creek should diversion of all or dry weather flow from the Creek be required or proposed.

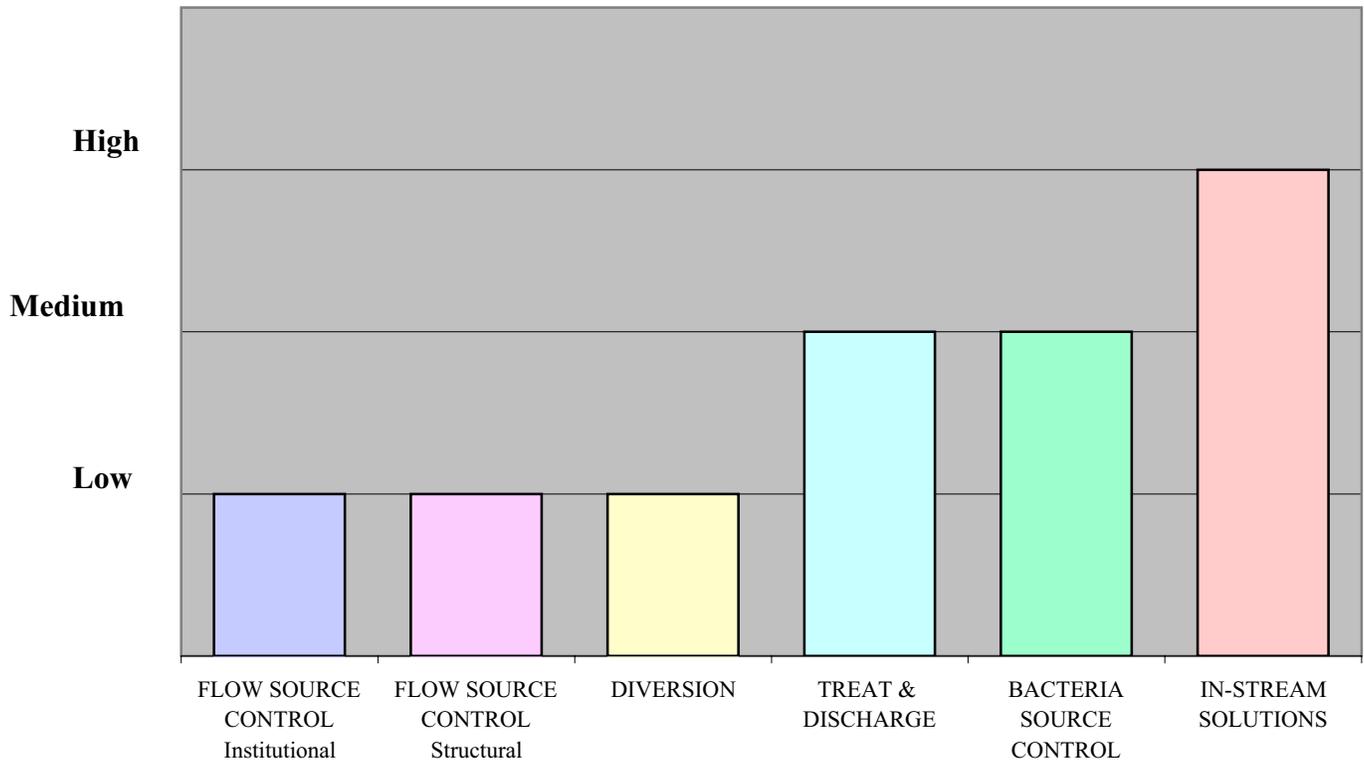
Any detailed studies proposed for Ballona Creek and/or Ballona Creek Estuary should be selected and designed to account for the results of and coordinate with a number of other related bacteria water quality studies that have been undertaken or are ongoing in Southern California and elsewhere. Examples of some recent related studies are contained in Attachment B.

Attachment A

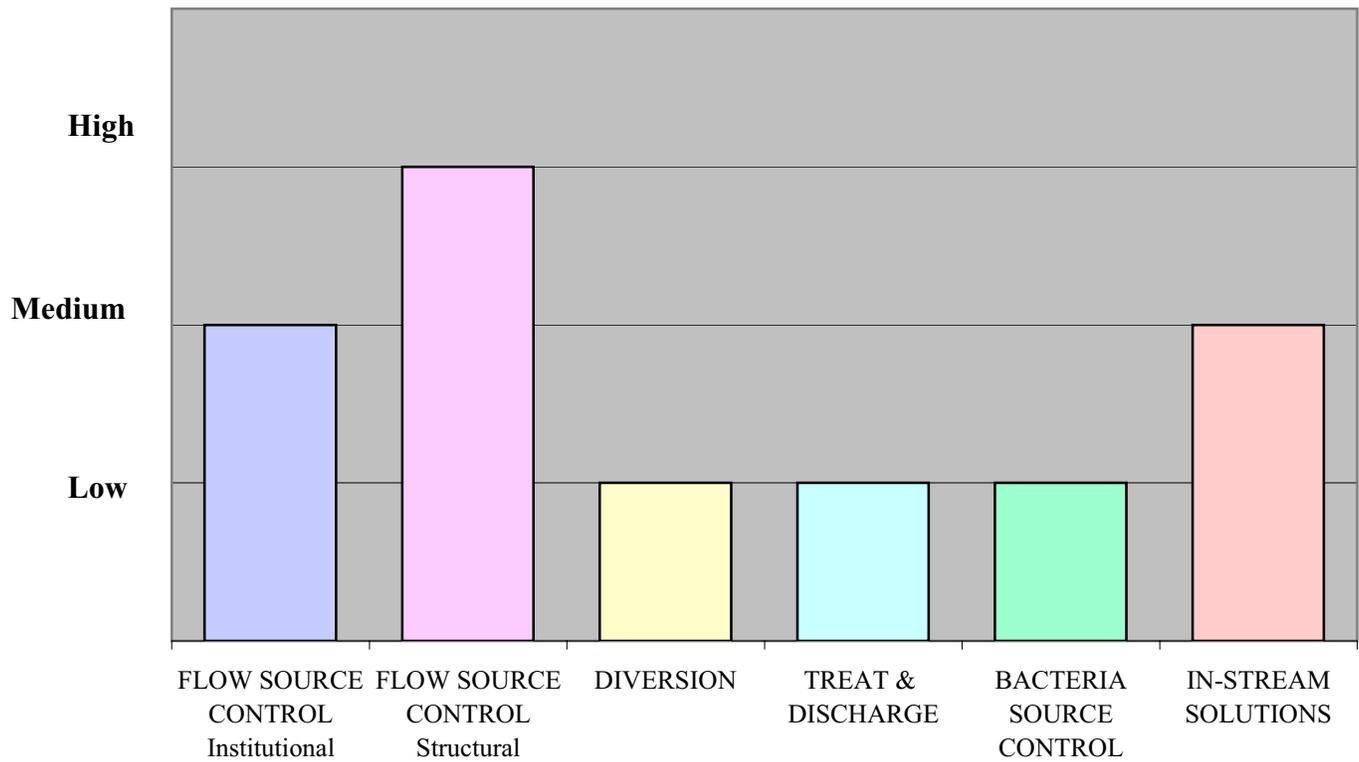
1.1 Protect for Recreation Use (where designated)



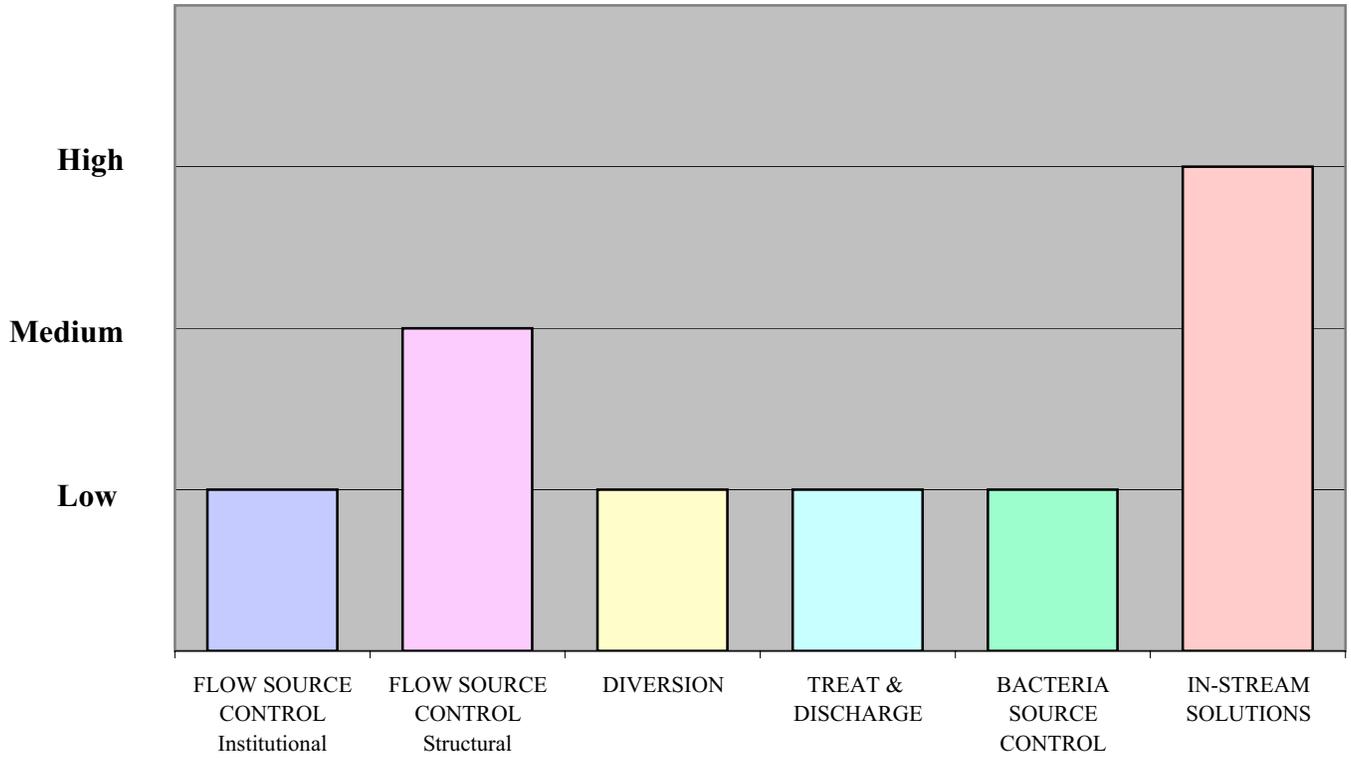
2.1 Improve/Restore Habitat in Natural Surface Waters



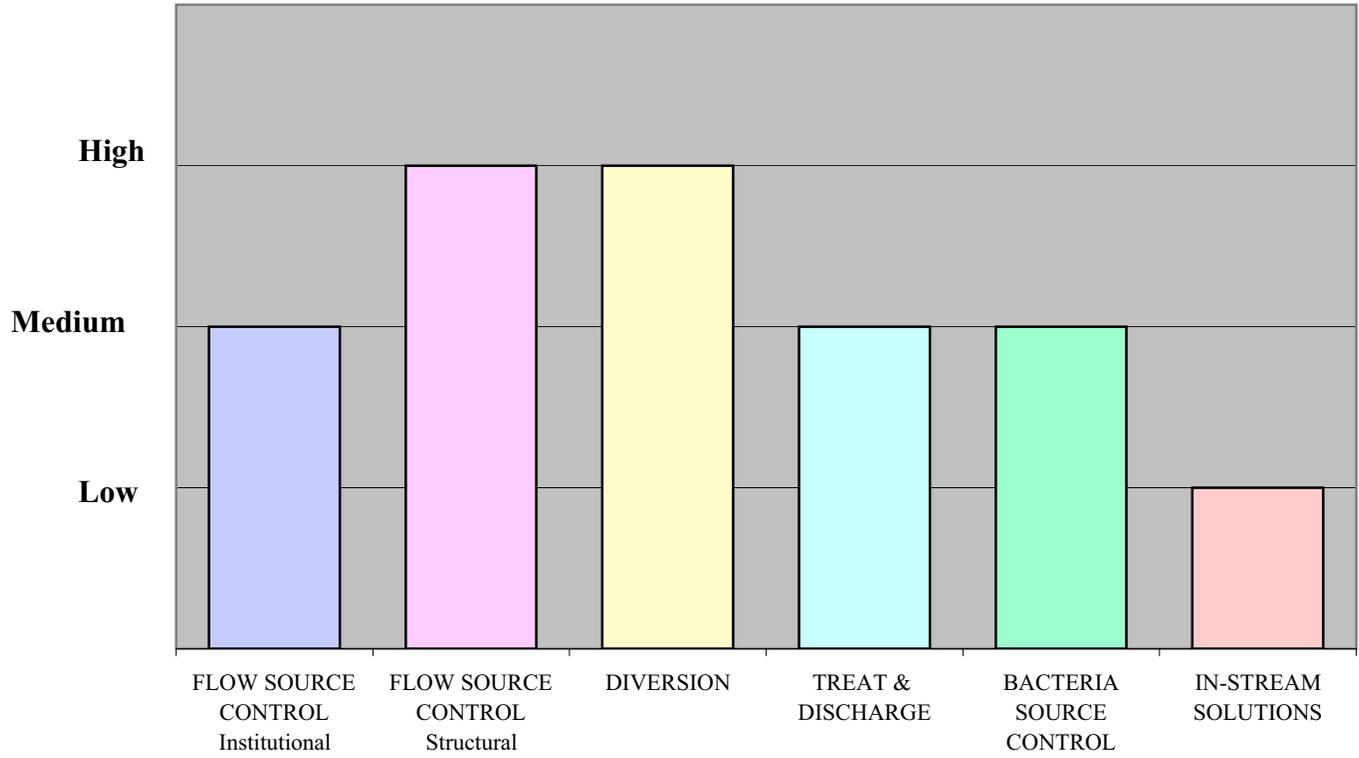
2.2 Provide for water supply benefits from runoff management



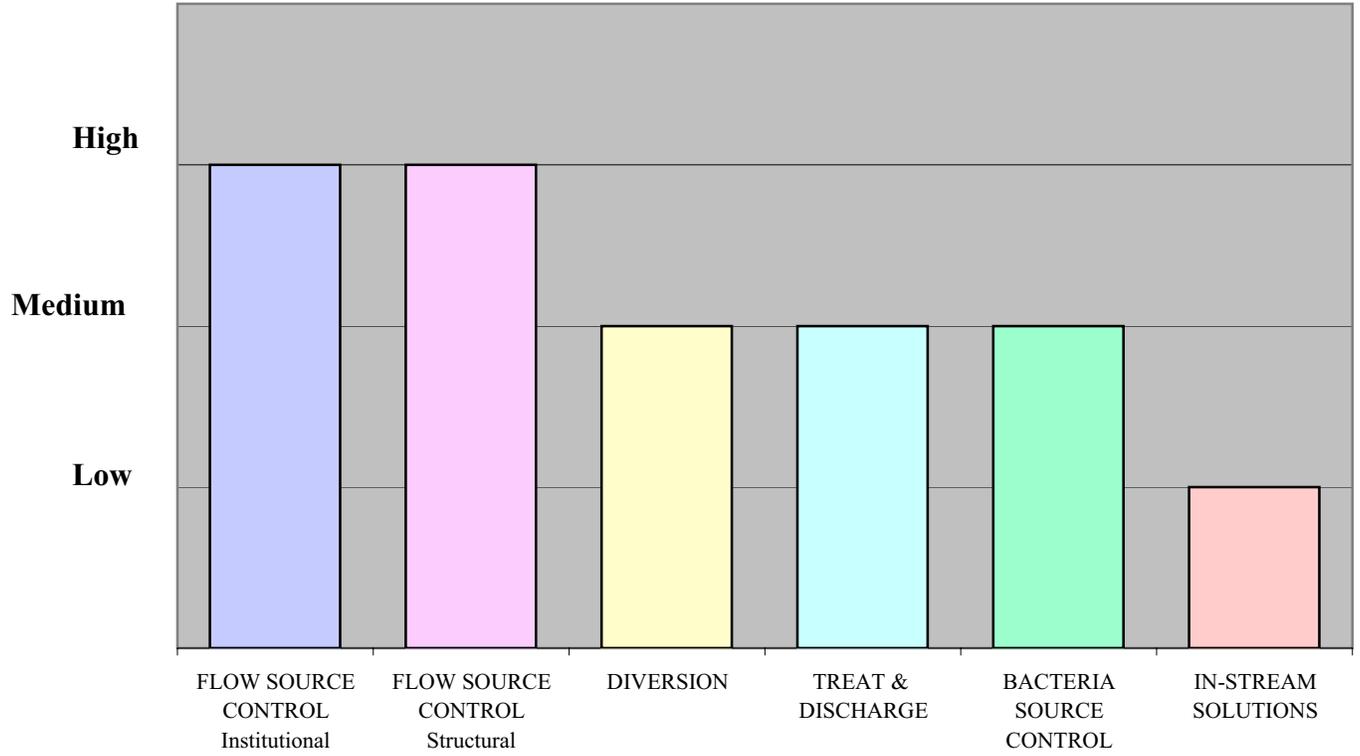
3.1 Provide Open Space/Enhance Land



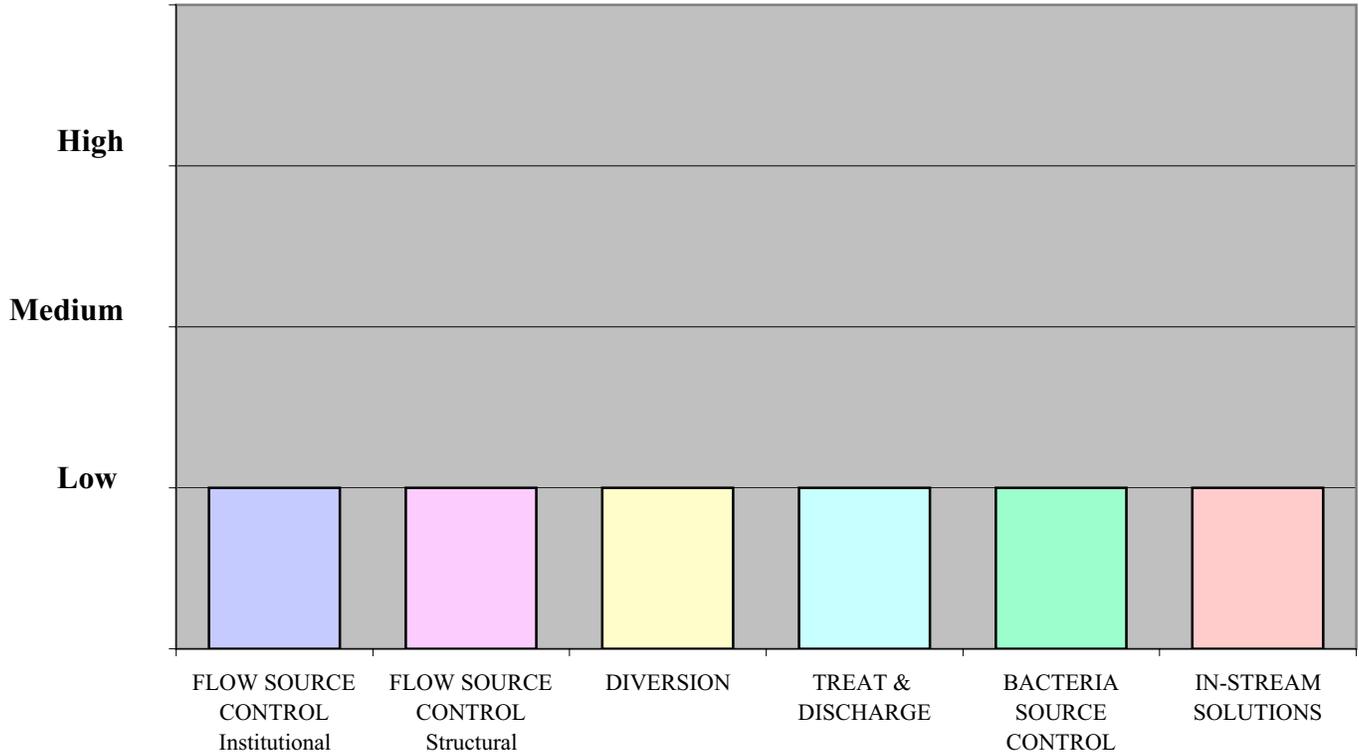
4.1 Certainty to Meet Target Levels



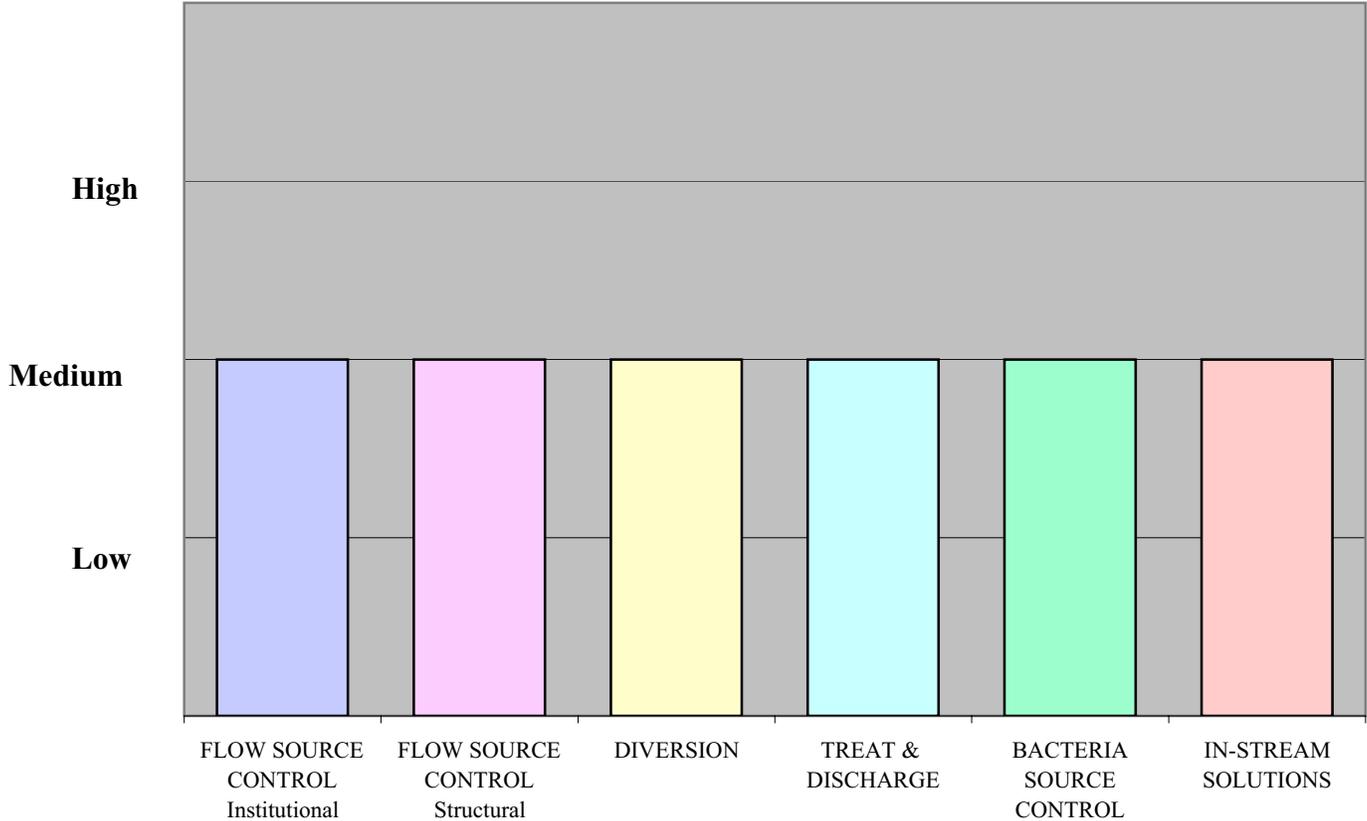
5.1 Provide Lower Cost Solutions



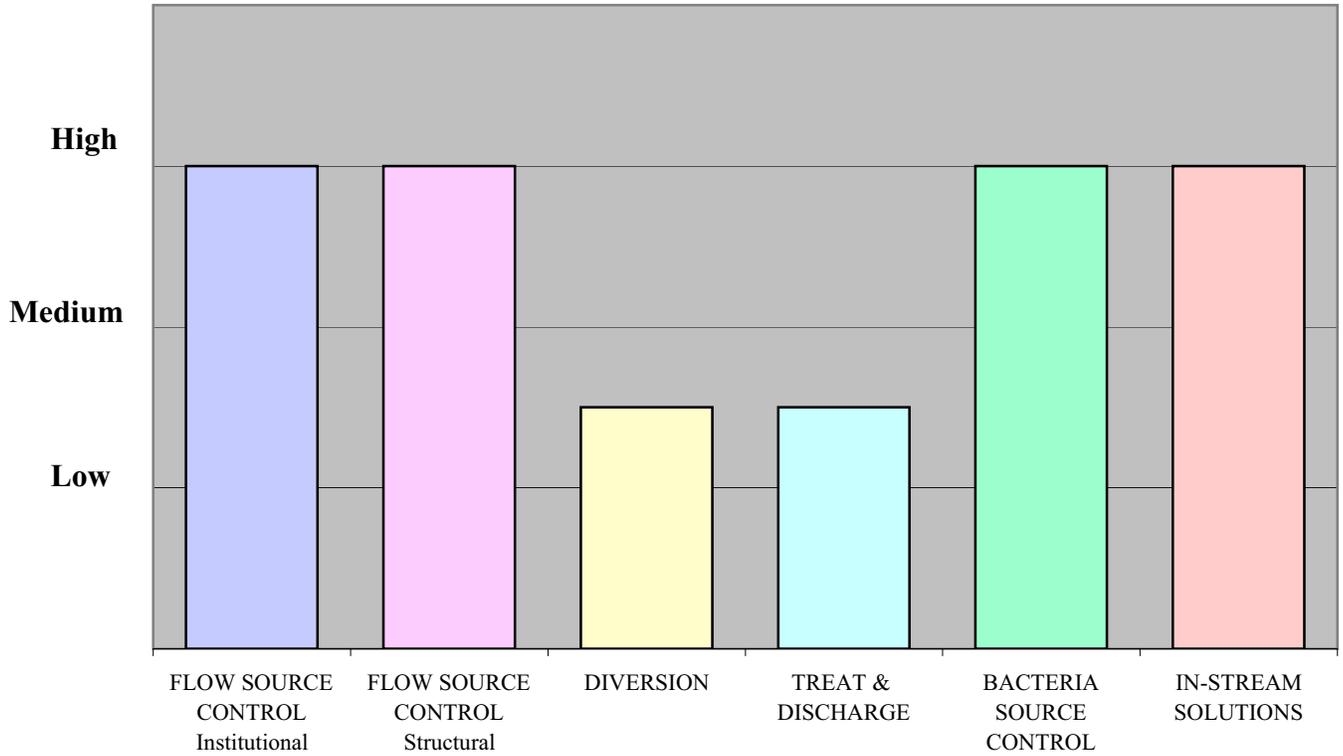
6.1 Effective Under Wet Weather Flow Conditions



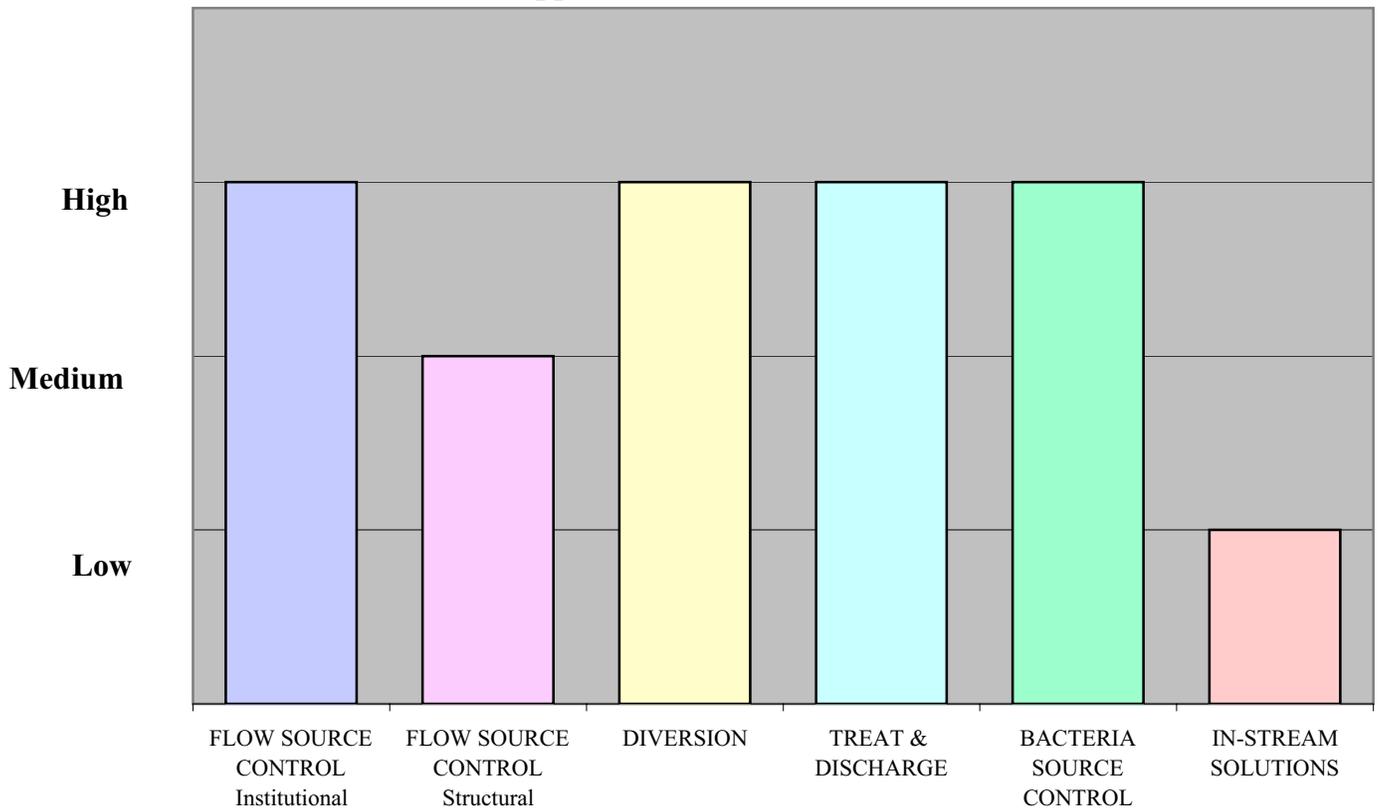
6.2 Effective for Other TMDLs (metals, toxics)



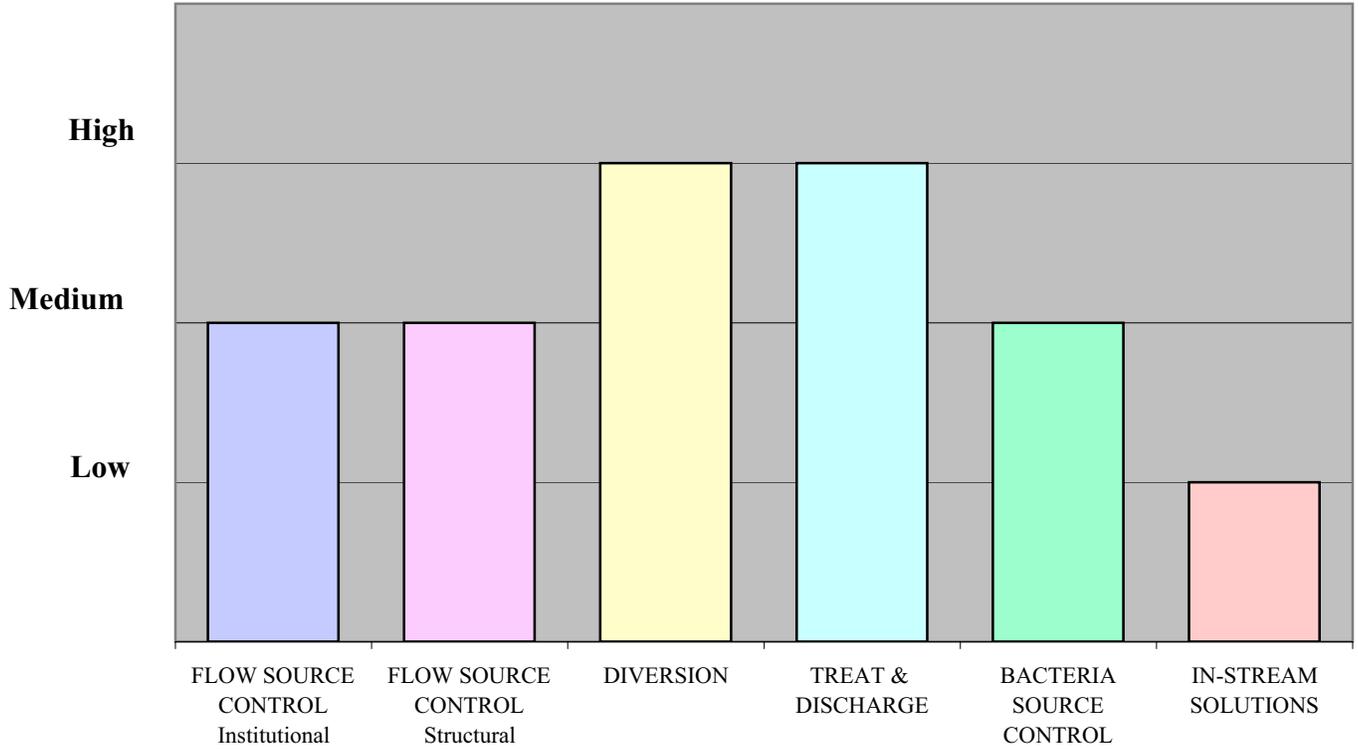
6.3 Ability to Implement Phased Approach



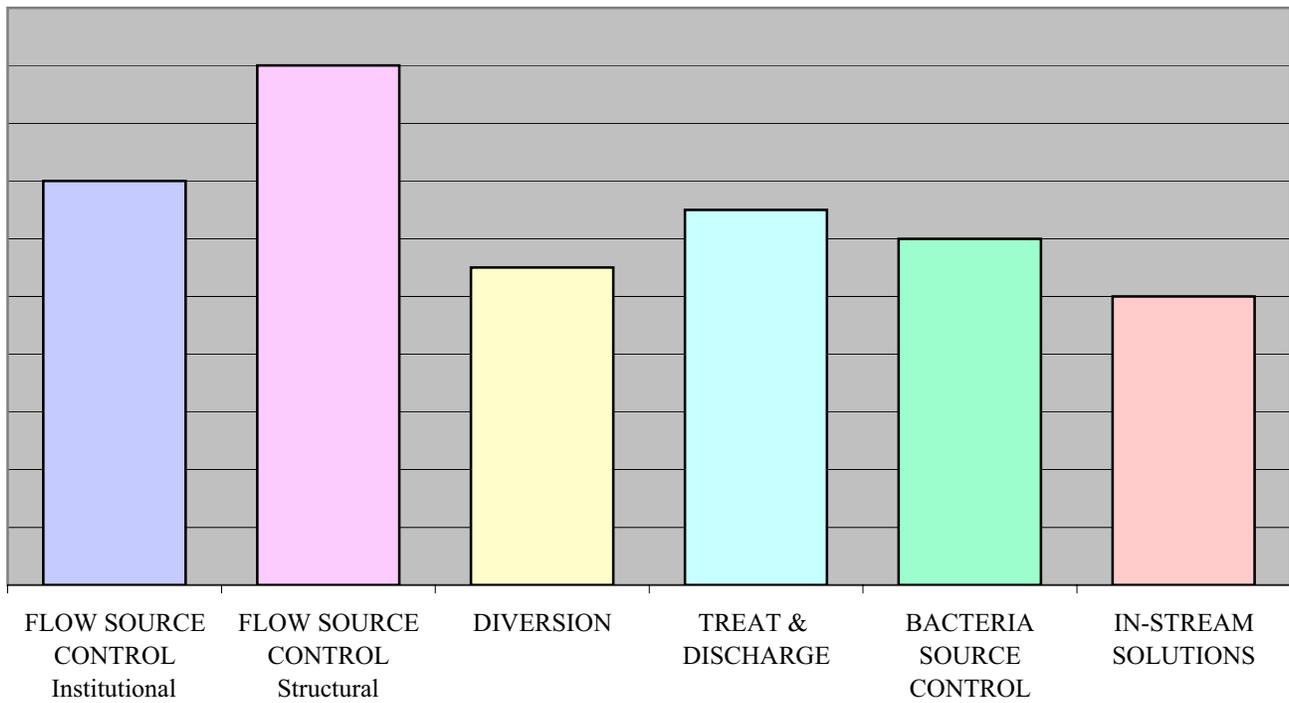
6.4 Applicable over Entire Watershed

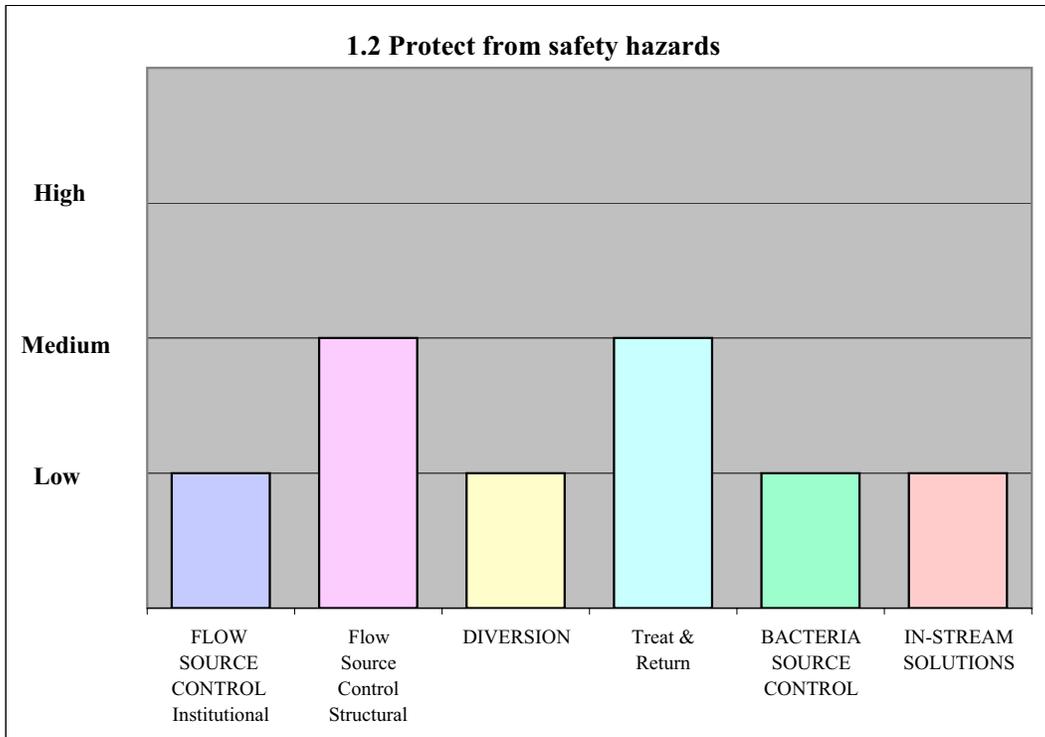
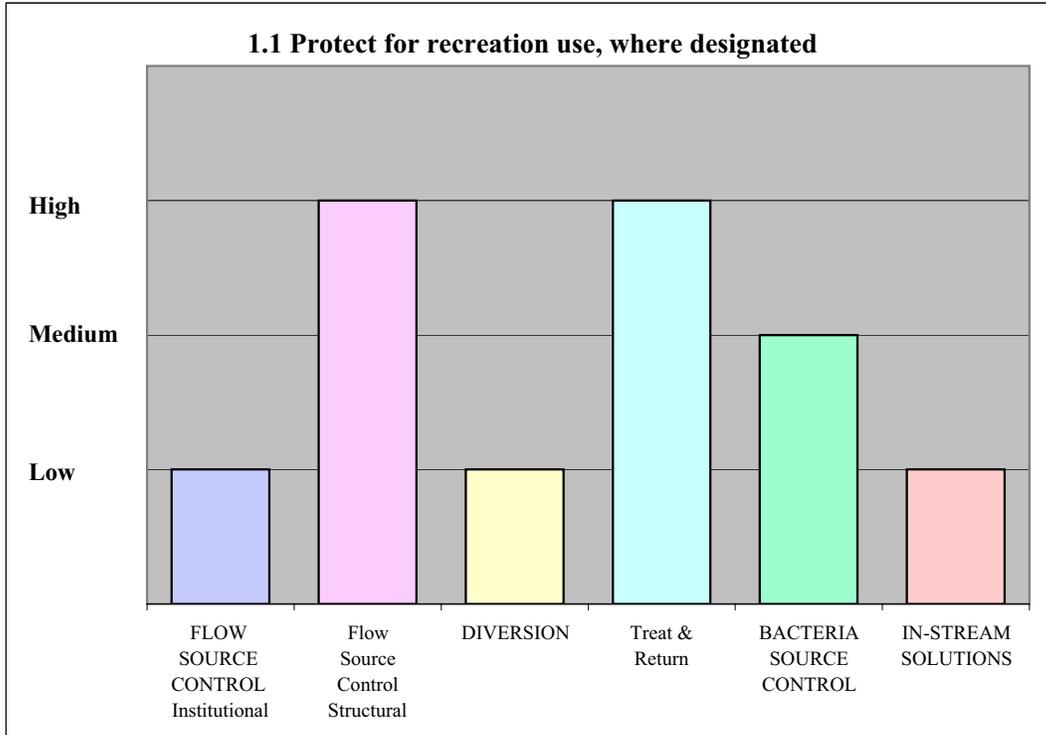


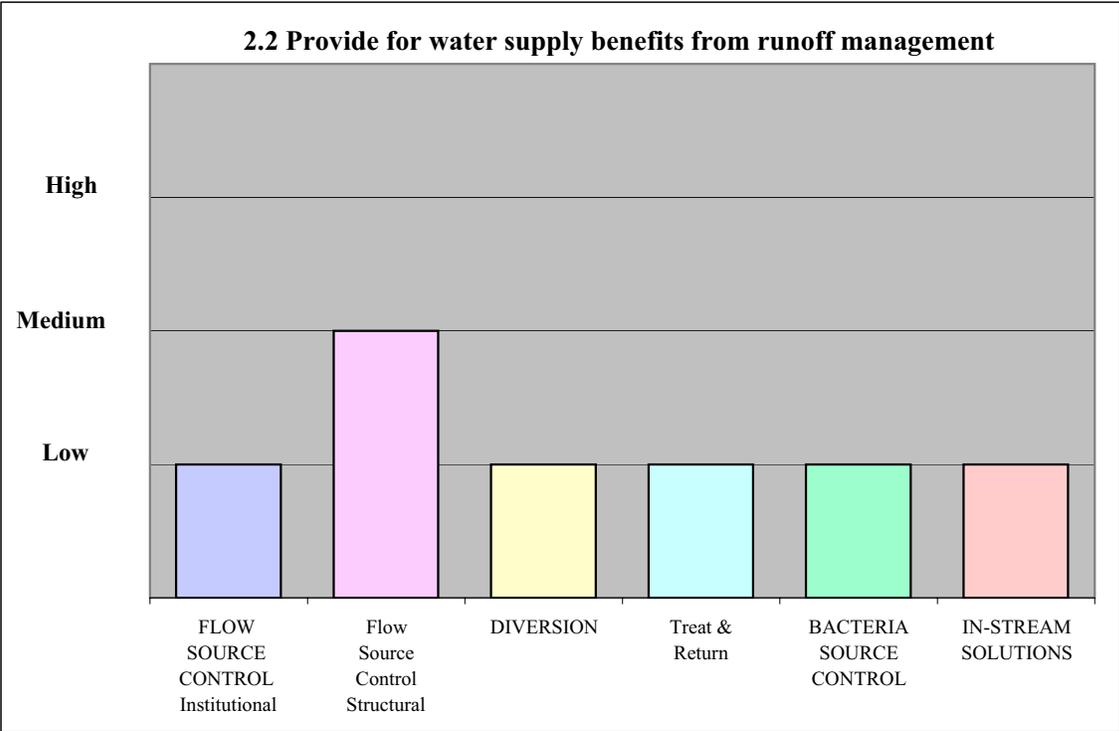
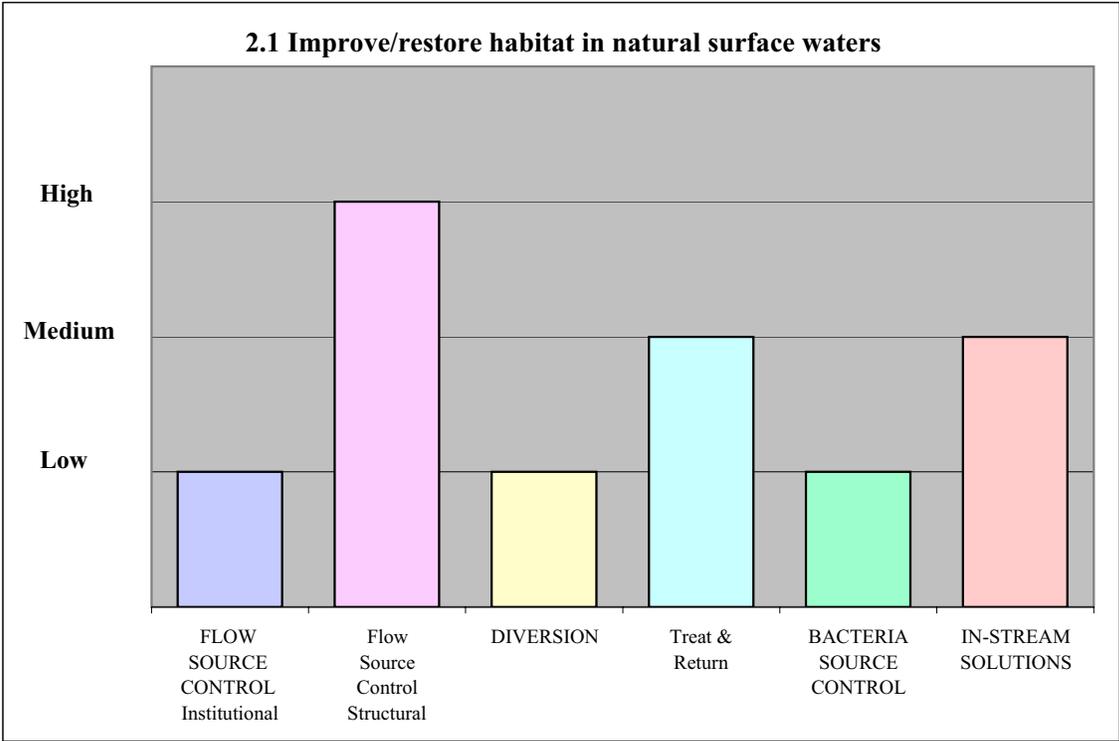
7.1 Improve Implementation Timeline

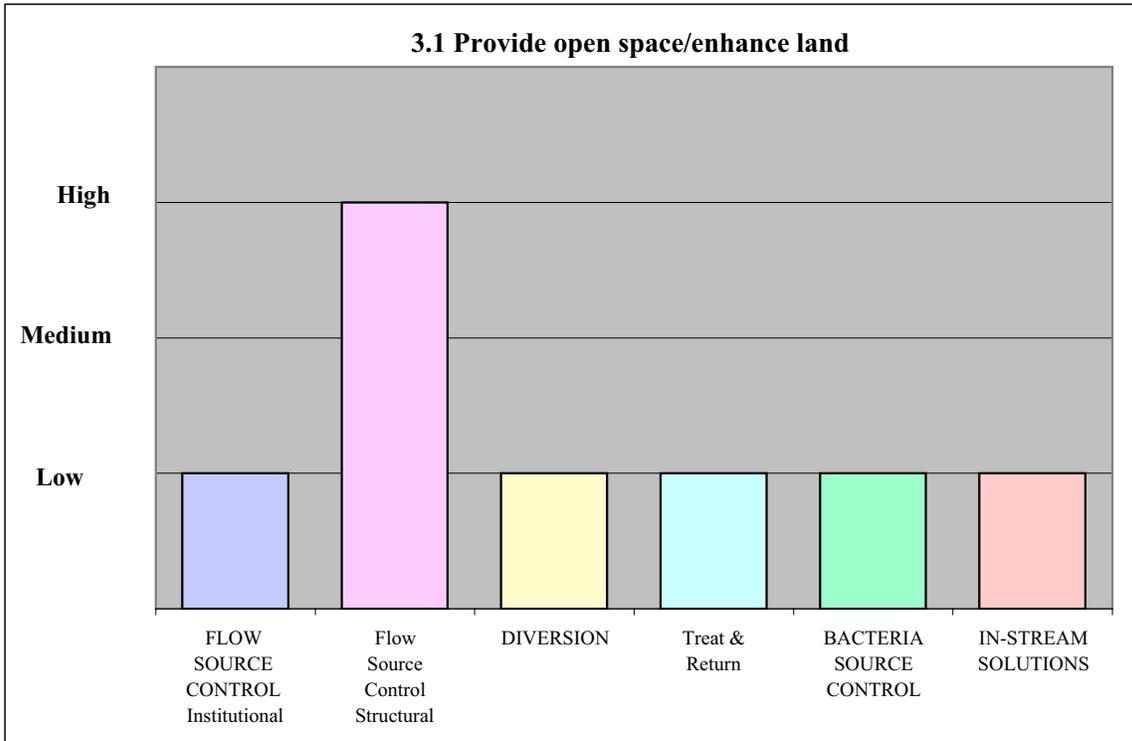


Dry Weather - Summary of all Objectives

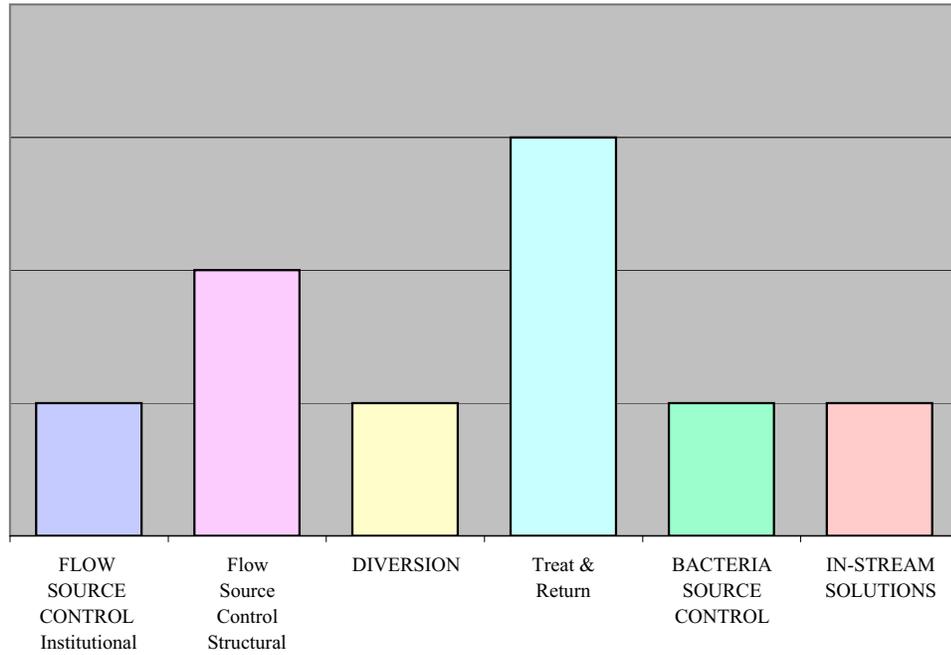


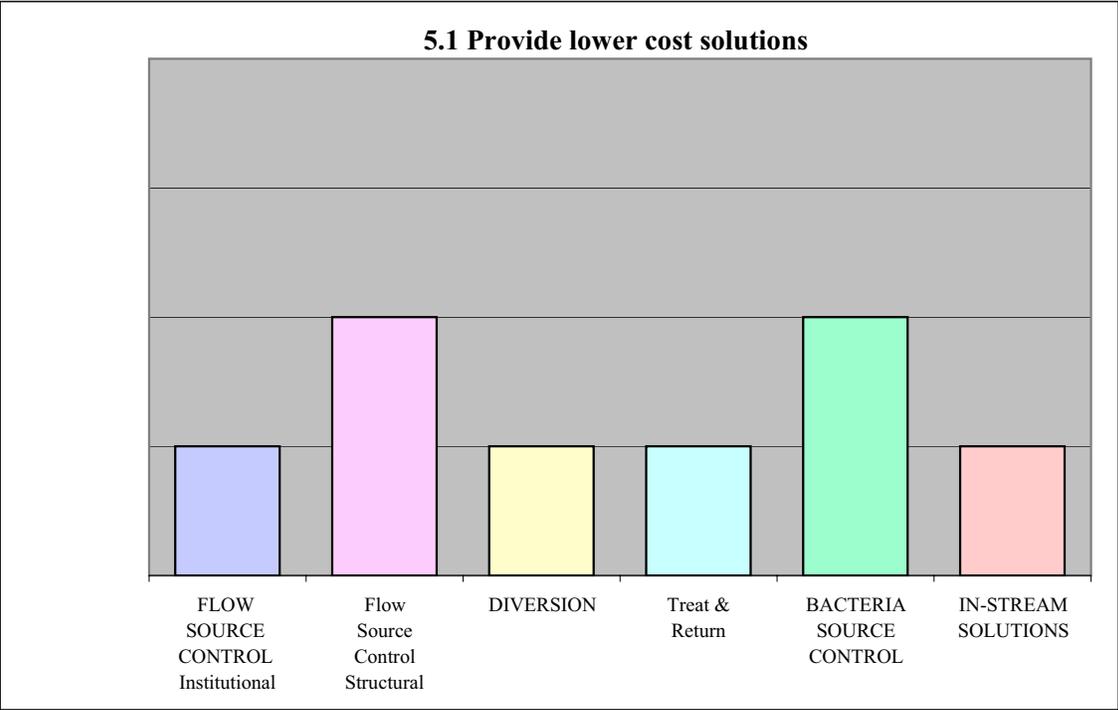




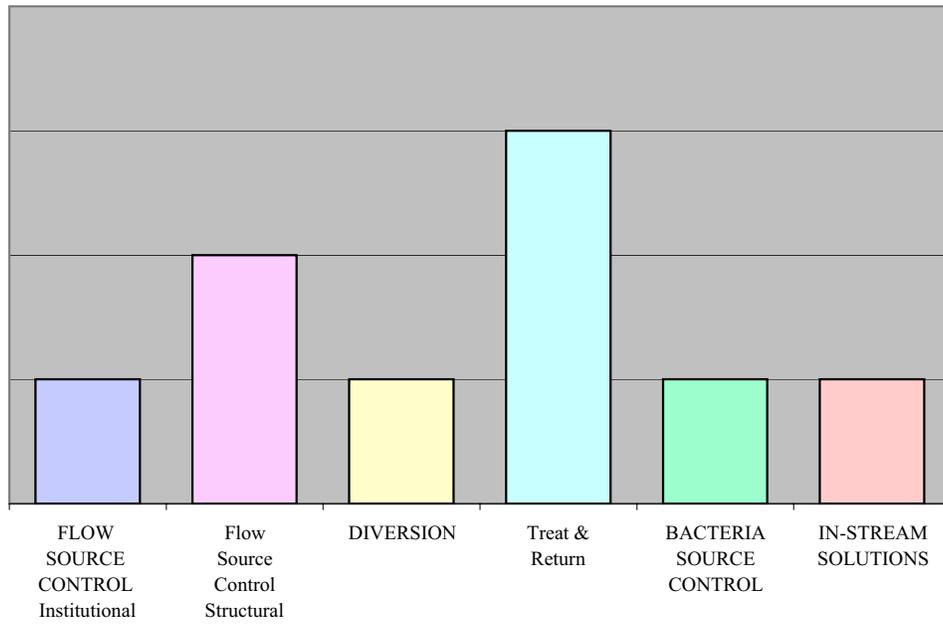


4.1 Certainty to meet target levels

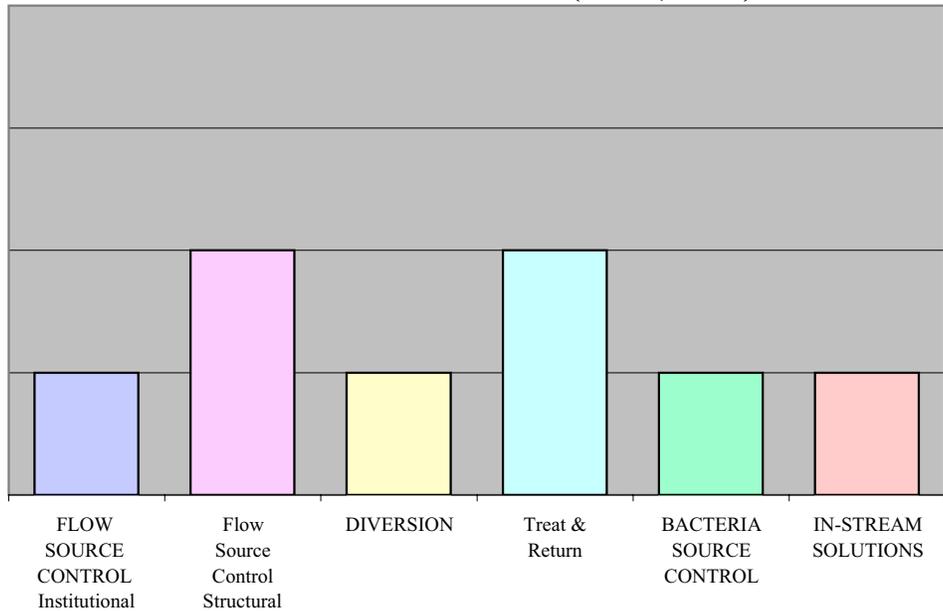




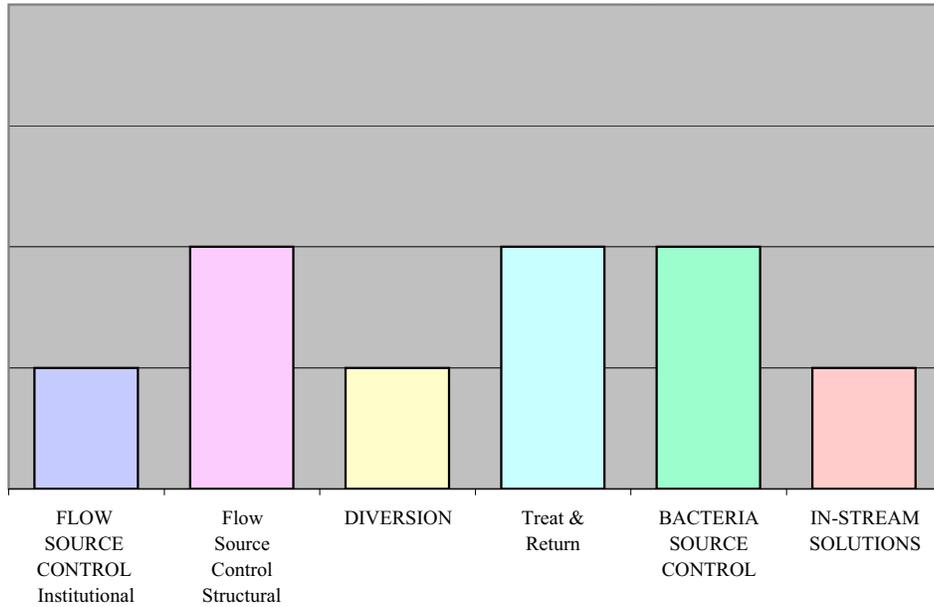
6.1 Effective under other flow conditions



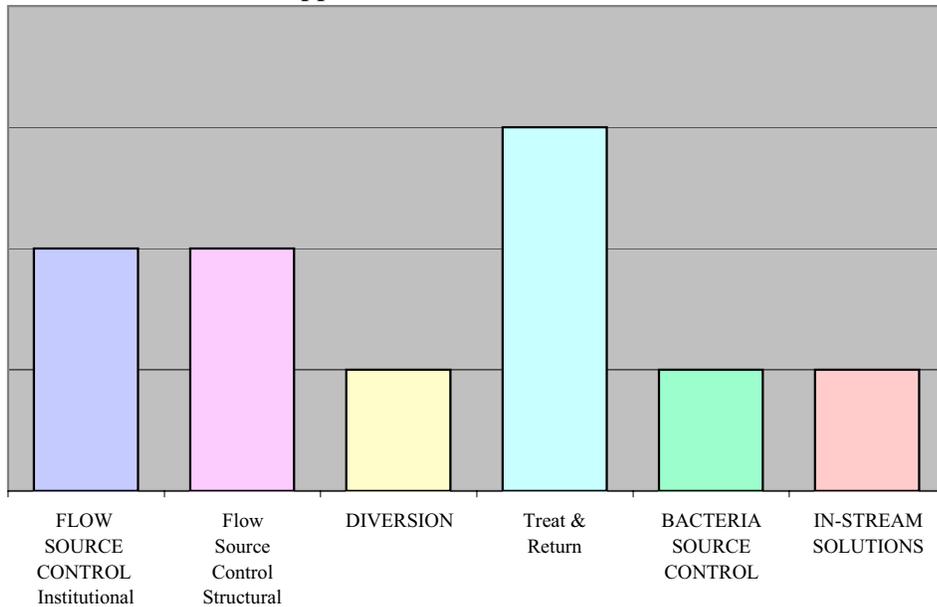
6.2 Effective for other TMDLs (metals, toxics)

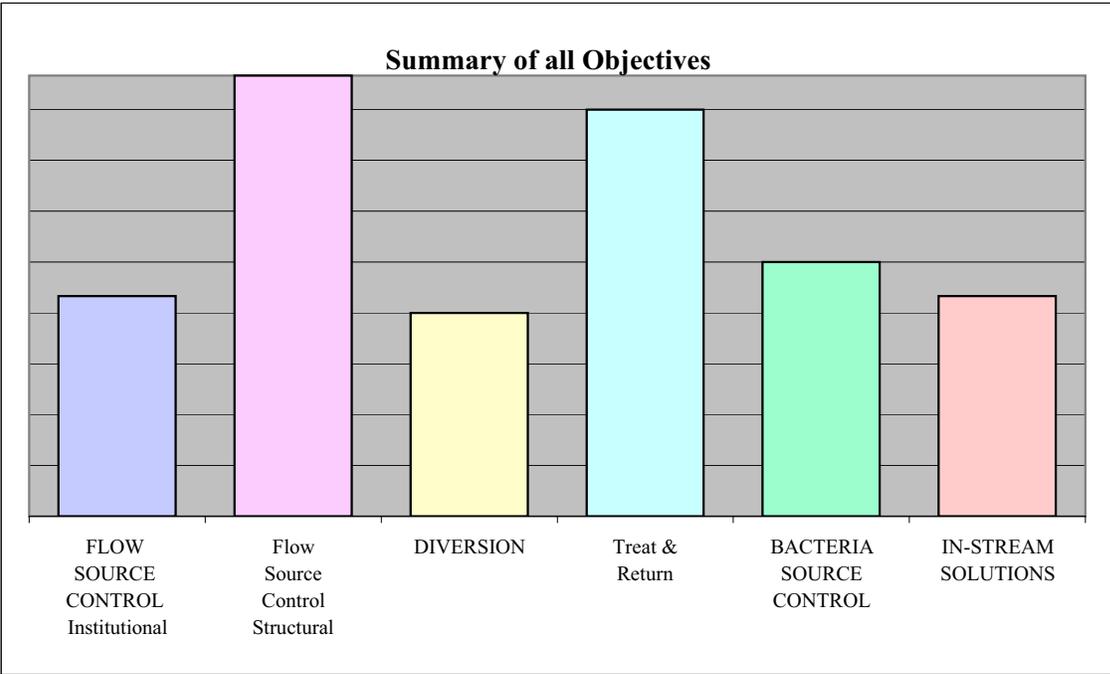


6.3 Ability to Implement Phased Approach



6.4 Applicable over Entire Watershed





Attachment B

Attachment B - Examples of Related Studies

Report Title	Year	Summary
An Economic Impact Evaluation of Proposed Storm Water Treatment for Los Angeles County	2002	Based on a series of potential design storm assumptions (70, 90 and 97% of storm intensities) and treatment to remove the most challenging 303(d) listed impairment (often metals or “legacy” pollutants) for each water body, flow based treatment costs were generated and processed in a regional economic impact model to estimate direct and indirect costs on a City and Regional Basis
J01P28 Interim Water Quality Improvement Package Plant Best Management Practices	2004	Bacteria impairments along Aliso Creek have been a continuing challenge. A package filtration and UV light disinfection facility was installed adjacent to the energy dissipation basin for the J01P28 outfall from a primarily residential urban neighborhood. Although the treated effluent normally met REC1 standards, within fifty feet indicator bacteria counts had risen an order of magnitude and the discharge no longer met these standards.
2004-05 Los Angeles County Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) Permit Annual Report	2005	The City Certified MS4 Permit Annual Reports indicate how the municipalities are currently meeting Permit requirements. Since future MS4 Permits also appear likely to be the implementation guidance document for municipalities, these reports are a valuable tool for assessing how compliance can best be achieved in the future. They also include estimate of program cost and staffing resources available to the 84 MS4 Permittees.
Ballona Creek Treatment Facility Feasibility Study and Preliminary Design	1996	Detailed investigation, pilot plant operations and preliminary design for the potential conversion of the existing North Outfall Treatment Facility in Culver City on Ballona Creek to serve as a dry and wet-wet treatment facility.
Recreational Water Contact and Illness in Mission Bay	2005	Predominate sources of indicator bacteria appear to be non point. Epidemiological endpoints of rash and diarrhea in young children did not appear correlated to State Water Quality Standard Exceedance.
Management of Pathogens Associated With Storm Drain Discharges	2002	Significant concentrations of indicator organisms are nearly ubiquitous in urban drainage. There does not appear to be a relationship between pathogens and indicator bacteria.